

Fort Yukon Woody Biomass Project

Final Report - USDA Rural Development
Rural Business Opportunity Grant for:

- : Biomass Harvest Equipment Assessment*
- : Transportation Systems Analysis*
- : Contract Agreement Formulation*

February, 2009



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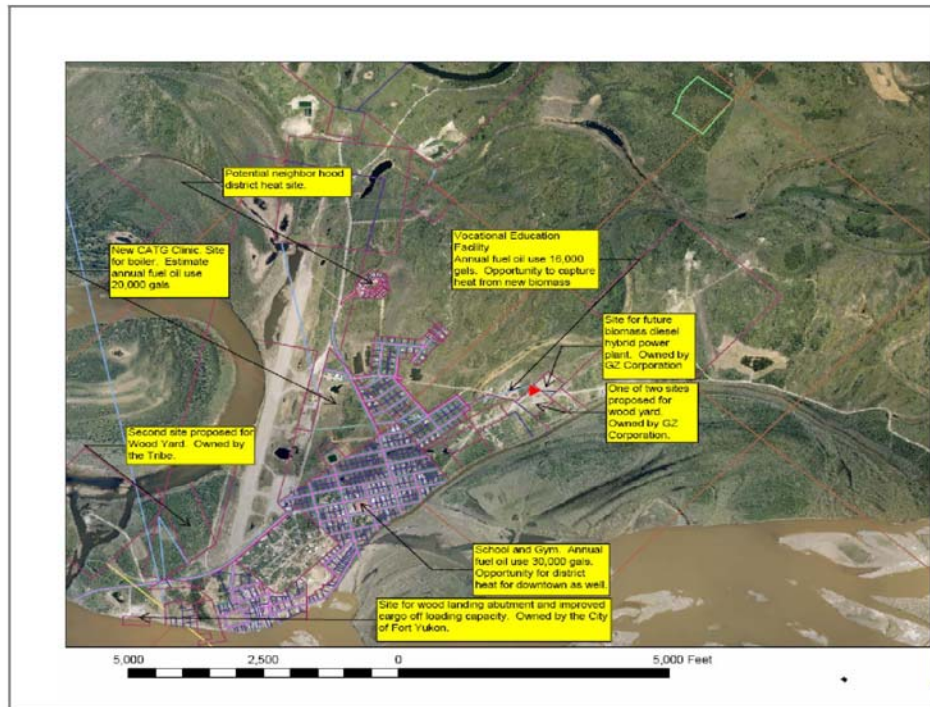
II - Introduction

Alaska Village Initiatives and others have been developing a renewable energy program utilizing local forest resources for rural Alaska. Successful implementation of this program has the potential to create jobs, displace imported diesel fuel with locally produced wood fuel, and to improve forage and habitat for important subsistence species such as moose. Fort Yukon is likely to be the first community to launch the program for their community.



Solar panel installation in Fort Yukon

Considerable effort has been made to get the program to this stage in Fort Yukon. A Forest Stewardship Plan for Gwitchyaa Zhee Corporation, the local Alaska Native Claims Settlement Act village corporation was completed in 2007 which focused on the potential for a woody biomass harvest for energy. Another project funded by the Department of Energy is nearly complete which evaluates and quantifies the potential wood consumption in several communities in the Yukon Flats.



Fort Yukon community heating system layout map

Three key issues needed to be looked at in more detail however. These include a biomass harvest equipment assessment, a transportation systems analysis, and contract agreement



New housing constructed from local forest resources

formulation. The harvest equipment assessment defines the equipment that an initial harvest program will need in order to produce the wood fuel. The transportation analysis looks at the issues related to water depth and ice thickness requirements for hauling equipment and wood fuel cargo in the context of the harvest equipment assessment recommendations. And finally, the contractual agreement formulation portion discusses and presents a contract template for harvesting woody biomass and for the sale of that biomass as wood fuel to a long term customer.

We hope and expect that this report will be an important contribution to the renewable energy efforts using woody biomass in rural Alaska.

III -Biomass Harvest Equipment Assessment

Background

The decisions leading up to a wood biomass harvest system design and the determination of each of the systems components is a critical step towards implementing a successful wood fuel project in rural Alaska. Rural Alaska poses numerous challenges to operating a small-wood harvest program experienced few other places in North America.

A clear recognition of the tasks that the equipment is expected to perform within the financial and environmental parameters of the harvest program is prerequisite to the proper choosing of the harvest equipment. Productivity, dependability, and ease of maintenance are key long term issues that are largely set at the time of acquisition of wood harvesting equipment. The difficulty and expense of delivering heavy equipment to bush Alaska make regrettable initial harvest system component choices difficult to overcome later.

The boreal forest in Yukon Flats is comprised of white spruce, poplar, some birch, and numerous varieties of willow. In most cases, each of these species could be suitable to use as wood fuel. Due to the forests small average tree size, a harvest system that could handle stem diameters up to 16 inches would be adequate in most cases to process the majority of the woody biomass found in the project area. The topography is very gentle, and in most all sites observed the forest soil is capable of supporting ground based harvest systems in summer and winter conditions.



Yukon Flats hardwood stand

Financial Parameters

The ultimate purpose for a woody biomass harvest program in rural Alaska is to stabilize and reduce energy costs to the community. This is possible only if quality wood fuels are delivered to the consumers in the village dependably and economically. Prospective wood fuel consumers need assurances that if they invest in wood fueled heating systems that a wood fuel supply will be available at terms that allow them to reduce their fuel costs per BTU and to recover their investment in the new boilers within a reasonable amount of time.

Fort Yukon can potentially displace 135,000 gallons of heating oil consumption with approximately 2,500 tons of wood chips using existing wood fueled heating and distribution technology. Most residences heat with wood and heating oil. Another 10-20,000 gallons of heating oil may be displaced with stick firewood in smaller residential applications if reliable and high quality firewood supply is developed. Additionally, should reliable and

appropriately scaled wood fueled electrical power generation technology become available, wood fuel could theoretically displace an additional 200,000 or more gallons of diesel fuel if the amount of chips harvested were more than doubled.



Fort Yukon oil tank farm

The potential annual gross sales income for 2,500 tons of wood chips sold at an average cost of \$125/ton equals \$312,500, and for sales of 300 cords of stick firewood at \$250/cord is \$75,000. Together, wood chip and firewood sales total an estimated \$387,500 annually. All of the activities related to the wood fuel program must not exceed this amount if no other revenue can be generated with the resources the wood fuel program has at its disposal.



NRCS Forester in willow stand

If 35% of the annual gross sales were to be budgeted for equipment, then the annual equipment capital budget would then be \$135,625. Under these assumptions this annual capital budget would be capable of paying lease or loan payments for approximately \$600,000 worth of equipment loans using a 6 year payoff assumption.

Physical Parameters

For financial and physical constraints, the targeted equipment size for this project is for machines in the 8 ton gross weight range. This equipment must be able to do all of the harvest, processing, and delivery tasks for 3,000 tons of wood chips and 300 cords of stick firewood annually.

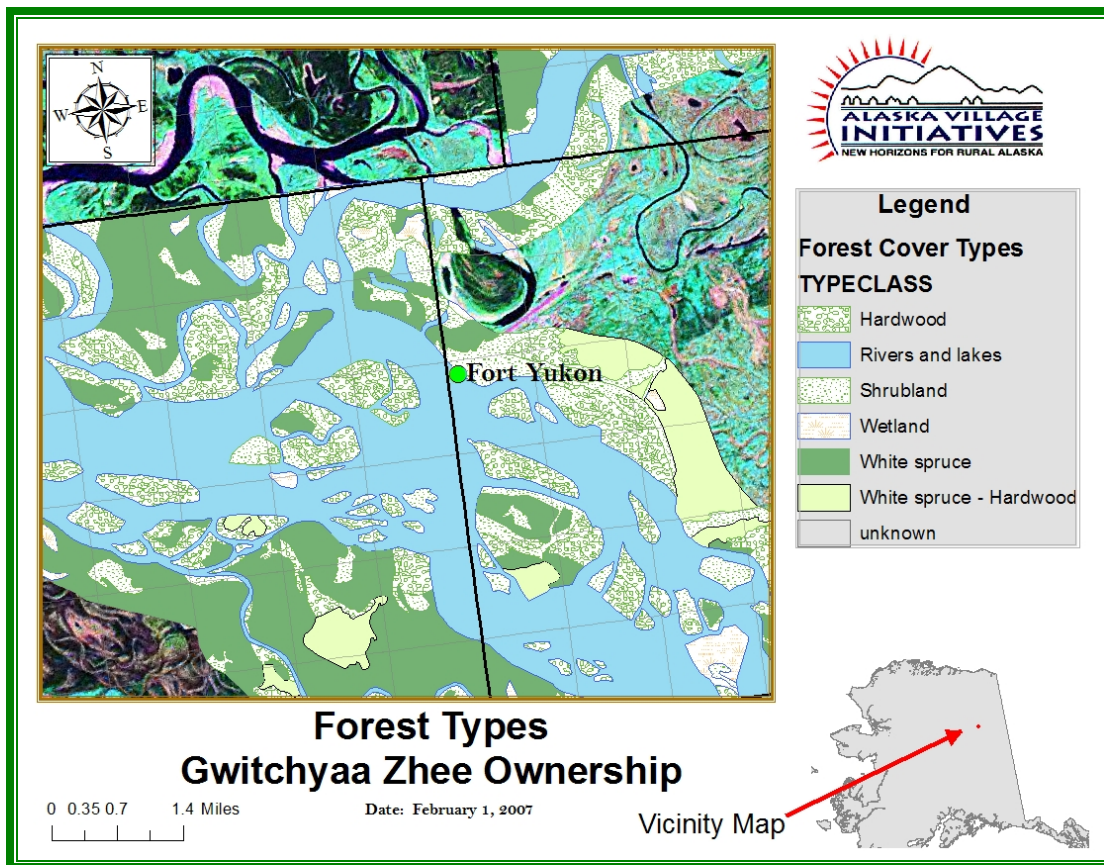
The physical weight constraints are due largely to the necessity to transport and operate the equipment over the river systems in the region. During ice free periods, equipment and some wood fuel production will be transported by landing craft or barge. Due to extended periods of low water flow, the equipment must be able to be transported in smaller craft that can work in shallow water conditions that

occur in many of the harvest locations. Similarly, the carrying capacity of the ice on these rivers and ponds during the winter season also encourages the use of lighter machinery.

Each machine will need to be properly equipped to operate in Arctic temperatures. This includes being well equipped with lights, as well as engine block and battery warming capabilities.

Timber Harvest - Overview

Approximately 125 acres of forest will be harvested annually for the production of 2,500 tons of wood chips and 300 cords of stick firewood. It is necessary to plan for both summer and winter harvesting in order to meet these production goals, particularly in the first few years. Accordingly, the harvest system must be capable of working well in the extreme temperature ranges found in this region.



The forest is widely distributed over the 214,000 acre ownership of the Gwitchyaa Zhee village corporation. The road system in this area is limited to within a short distance of the village. Economics severely limit the feasibility of road construction for the harvest activities. Therefore, the harvest program must be able to operate in a remote, roadless setting on an ongoing basis.

The harvest system as a whole must be flexible enough to be used in both summer and winter applications. A key issue is determining how much woody biomass will be produced during each season. Summer activities will require mobilization and wood fuel transport via landing craft or small barge, and winter harvesting can only occur when and where ice thickness is adequate enough to support the expected load weights. Operations must be located and configured where they can be carried out both efficiently and safely.

Each harvest site will have its own set of unique circumstances that will influence harvest implementation. The operations manager must learn how to recognize each sites characteristics and risks in order to make preparations to address any specific challenges well in advance of mobilizing equipment and personnel.

Timber Harvest- Tree Felling

Fuel wood harvesting systems in rural Alaska must be able to efficiently produce both stick firewood and wood chips. The majority of stick firewood in bush Alaska is white spruce. Where available, birch can also be used for this purpose although it is rarely observed in the Yukon Flats region. Wood chips can be produced from most tree and shrub species. Much of the standing forest inventory of woody biomass is in hardwood species such as aspen, poplar, and willow.



14" felling shears on wheeled skid steer

The weight and financial limitations that the project must operate within influence the maximum size of trees that the equipment will be capable of safely handling. It is anticipated that the majority of timber harvested will be whole tree chipped. In this case, it is likely that the largest diameter that will be mechanically harvested is 14" to 16". Hydraulically powered tree shears provide the most economical and reliable option to mechanically fell timber of this size. For larger (14"-16") stems, the shears could be mounted on a 100 - 140 hp industrial track skid steer. Smaller shears can be mounted on 60 hp excavators with the hydraulic plumbing and controls suitable for this

purpose. The excavator mounted shears would be suitable to harvest 8"-10" stems such as willow or smaller poplar and birch.

It is important to note that these size limitations are smaller than some of trees in the forest. The decision of whether or not to hand fell the larger stems will be made on-site. It is likely that in many cases the larger stems will simply be left standing while the smaller stems are harvested, achieving a desirable partial cut harvest pattern in some areas.

Timber Harvest-Skidding and Loading

Once the tree is felled it will need to be skidded to either the chipper or firewood processor in the field when appropriate, or to the village in log form. The machine that does these tasks once again needs to be versatile, reliable and within the 8 ton weight range.

Modern tracked skid steer machines are ideal for these applications. Some of the manufacturers produce configurations of their machines that are purpose built to fit the needs of forestry applications. These configurations need to have all the safety specifications mandated by OSHA, particularly with regard to cab roll over protection and windshields. They also have the versatility of being able to use the many skid steer attachments that are available for a wide variety of applications. If the machine has high flow hydraulics it may also have application to



Fecon FTX90L with skidding grapples

be used with a mulching head for site clearing and preparation. Caterpillar, ASV, Bobcat, Fecon, and Takeuchi are all popular machines with high flow options and “forestry packages” (undercarriage guarding, Roll Over Protection, etc) available. Of these, Fecon seems to lead in the development of some of their smaller models such as the FTX100L and FTX148L specifically for these types of forestry use.

These Fecon models are well suited for an industrial forestry and site preparation program as envisioned for Fort Yukon. They can be used as a carrier for log skidding with grapple or cable arch, as a tow

vehicle for a small log forwarding trailer, as well as a log loader with front end grapples that are available in a variety of configurations. One machine can be used to fell, skid, and load logs if called upon to do so.

Attachments

Like all skidsteer machines manufactured today, the Fecon models can employ most attachments made for these types of machines. It is highly recommended that several attachments be purchased for this program. These include a rake grapple, gravel bucket, dozer blade, 14” felling shears, Fecon mulching head, snowblower, and firewood processor for the front end of the machine. A rotating logging grapple should also be purchased for the back of the machine.



These attachments are a relatively low cost option to make the skidsteer a very versatile machine that can be reliably called on to accomplish a variety of tasks. This versatility will prove to be an invaluable asset over the life of the project by supplying the proper tools for specific situations as they come up without having to use a different machine for each specific task.

Excavator

A small 7 to 8 ton excavator will have a number of applications for the harvest program. It may be called upon to do small excavating tasks related to landing sites along the river, fell and possibly process smaller trees, handle logs and trees with a grapple, and the various lifting needs that this type of operation will need.

The excavator should be equipped with one or two auxiliary hydraulic outputs to run a hydraulic thumb and other attachments. It will also need to be fitted with forestry guarding and a Roll Over Protection System (ROPS) cab. The windshield should be either made with Lexan or have a shield of Lexan in front of the windshield for additional operator protection.



8 ton Takeuchi excavator

Manufacturers such as Kubota and Takeuchi have the extra hydraulics as standard equipment on their 7 ton models. They also come standard with a blade and independent swing capabilities which will prove to be helpful in a variety of situations.

Firewood Production and Processing



Arbro stroke harvester on 7 ton Hitachi excavator

For spruce and/or birch trees that will be used for stick firewood, the next step will be to limb and buck the tree. It is desirable to do this process mechanically for economic and safety reasons. Fortunately there are several small processing heads that can be operated from a hydraulic excavator or a skid steer tractor with the appropriate hydraulic piping and valves that are in the weight parameters of the program.

Processor heads such as Arbro and Kesla use the stroke delimiting method, and a hydraulically driven bucking chainsaw. This method effectively delimits stems and has the capacity to measure log lengths. The

arms on the head hold the stem in place as the delimiting knives are “stroked” along the stem bole using hydraulic cylinders. When the desired length is achieved the bucking saw cuts the log.

The system, while fairly simple and reliable, is slower than the wheel or track driven delimiting heads. The slower production places lower hydraulic flow demands on the processor head, which is why the smaller, lower flow machines can operate them effectively.

Consequently the higher speed roller feed systems have a very limited opportunity in this type of harvest program. The possible exception is a high-flow skid steer mounted processor head made by Hahn Equipment. While typically mounted on a larger excavator (14 tons or more), at least one has been installed on a Fecon FTX90L tracked skid steer. While this arrangement has some future promise, it has yet to be proven as an effective machine configuration for rural Alaska wood fuel harvest operations. This merits watching however since it may well prove itself useful in time. If the skid steer mounted processing configuration works, it could reduce or eliminate the need for an excavator to be a necessary component of the harvest system.

The Fort Yukon wood fuel project expects that a relatively low amount of the wood fuel consumed (approximately 300 cords annually) will be in stick form. Consequently, a large investment in delimiting and bucking machinery may not be warranted at this time.



Hahn firewood processor attachment on skid steer

There are several manufacturers of firewood processing equipment that produce equipment capable of meeting the expected production needs of Fort Yukon. Most of these machines, such as Blockbuster, Multitek, and Cord King, are portable and have a conveyor system that loads a truck as the wood is being processed. As a system these units cost anywhere between \$30,000 to over \$100,000 depending on size and configuration. Due to their size (processor and conveyor), transportation costs will be comparatively high, particularly to rural Alaska.

There are two difficulties with processing firewood with these types of machines. First, the initial purchase and transportation cost of the machine is high in light of the comparatively low annual production needs. Second, the machines will be difficult to transport and operate anywhere but in the village itself, thus requiring logs to be transported from the woods to the village for processing in most cases.

Firewood processing in the field is anticipated to be more efficient than in the village in many instances. The ability to process in the field provides an opportunity for firewood pieces to be handled less before delivery to the customer. This option is practical with a firewood processing attachment that can be mounted on a tracked skid steer such as the Fecon mentioned earlier. Hahn Machinery has recently made such an attachment available. Capable of producing up to 2 cords per hour in small logs, at a purchase price of \$23,000, the FP160 Firewood Processor seems an ideal fit for the project.

Wood Chip Production

Chipping is to a certain degree a simpler process than log production when the end use of the chips is as fuel and the chip specifications are such that they allow whole tree or whole log chipping. Whole tree chipping is highly preferred whenever possible since this task can conceivably be carried out by a single machine such as a Morbark 20/36 Whole Tree Chipper rather efficiently. This chipper, and others like it are small enough to fit the physical parameters discussed above and are able to accept materials up to 16” in diameter. They also have their own loading arm so they have the capacity to feed themselves.



Morbark 20/36 chipper

It is important to recognize however, that leaves, needles, and tree bark will be mixed in with the wood chips and ultimately burned in the boiler using whole tree chipping. These materials will produce more ash than if the wood chips were burned without them. The chip feed system for the boiler must be able to reliably operate with some percentage of bark and leaves mixed in with the wood chips. Also, chippers tend to need a regular amount of

maintenance, particularly so with the chipper knives. An operation that relies heavily on a whole tree chipper should anticipate these maintenance needs and be suited with extra parts and any special tools that may be necessary.

Some models are also available in a track configuration. These models are a bit more versatile than the lighter, less expensive trailer mounted versions since they can move under their own power. The value of the tracked versions to the Fort Yukon project is likely limited however, since most of them weigh in the 12 to 15 ton range.

A notable exception is the Vermeer BC1400TX. A small tracked chipper that is remotely controlled, the BC1400TX weighs under 6 tons and is capable of chipping logs up to 15” in diameter. It does not have a loading arm however, and thus would require a small excavator or skid steer to load it.

Wood Fuel Delivery

Many of the equipment mobilization issues discussed earlier also apply to the transporting of logs or processed wood fuel in that there are definite weight parameters in which the operation must work within. These constraints are often in conflict with the need to haul as much cargo per trip as possible in order to keep costs reasonable. Adding to the logistical challenges is the absence of all season roads to the forest resource and the likelihood that fuel production will need to occur in both winter and ice free seasons.

If all of these limitations are to be overcome regularly, the transportation system of choice will need to be reliable and highly versatile. The hauling system ideally should be able to efficiently haul both short distances, as in a forwarding operation in the woods, and longer distances of up to 10 miles for hauling wood fuel from the forest to the village.

The most reliable and readily available machinery that fits these requirements is the Morooka rubber tracked carriers. These machines are capable of being fitted with any number of attachments that are otherwise used in medium duty trucks. If fitted with a hook-lift system such as a Stellar Flex36 and the appropriate hook-lift container attachments, they are capable of hauling wood chips, stick firewood, or logs with relative ease.



Stellar hooklift system on highway truck



Morooka MST 1500

The use of multiple containers with the hooklift system enables the chipper and/or firewood processor to continue production while the carrier is away from the machine. Thus it is a highly versatile system that can be adapted to haul a variety of cargos with relative ease.

A medium duty truck outfitted with the same hooklift system as the Morooka will allow it to move the containers most efficiently once they reach the village. A single axle truck such as a Ford F-650 or similar with 27,000 GVWR and capability to haul 12-15 foot containers is sufficient for this task.

Shallow Water Work Boat

The lack of roads in the project area requires a work boat to transport equipment, crew, and wood fuel over the large river systems found in the Yukon Flats during the ice free season. There are two basic configurations available to fulfill this need. One is a landing craft type of boat capable of efficiently hauling 8 to 10 tons of cargo, and the other is a small barge with a work boat that is capable of pushing or towing the barge.



Aluminum landing craft in Fort Yukon

Both configurations must be capable of working in shallow water conditions under industrial demands. An aluminum hull with adequate plating for such applications has the advantage of being relatively light while also being durable enough to withstand the wear of hauling equipment and wood fuel. Such a vessel would require reliable diesel power and a durable propulsion system capable of operating in shallow water and capable of efficiently translating engine horsepower to thrust.

It is envisioned that in time at least some of the wood will be floated to the village in raft like form. When this method materializes, the workboat would also be called upon to tow or push the rafts as well. To achieve greatest versatility, the vessel should therefore be outfitted with heavy duty cleats for towing and push knees in the bow for pushing applications.

The landing craft configuration has the capacity to haul cargo and act as a small tug. It also is a bit simpler to operate as compared to a small tug and barge. A 40 foot aluminum hull landing craft configuration with a 14 foot beam can potentially have the capacity to haul over 9 tons of

cargo. A small pilot house located to the aft of the vessel situated either to one side of the vessel or elevated above the cargo space will optimize the usage of available deck space.



The vessel should be capable of efficiently loading and off-loading hooklift containers. In the woods, the hooklift equipped Morooka could back up to the landing craft and load the container directly off of the Morooka. At the landing site in the village, a truck equipped with an identical hooklift could back up to the landing craft and offload the container and deliver it to its ultimate destination.

For a craft of this size and application a single diesel engine with approximately 350 hp will be needed. Two smaller engines may also be considered at an increased cost.

There is likely only one propulsion system that can meet the demands of this vessel, and that is the jet propulsion system manufactured by Tractorjet. This propulsion system is an industrial jet design capable of being coupled with a large number of marine application diesel engines. It has the capability to operate efficiently in shallow water depths and under varying load conditions. According to the manufacturer, the Tractorjet has efficiencies very similar to propeller propulsion and can be used in planning hull applications.



Report authors on Yukon River 2008

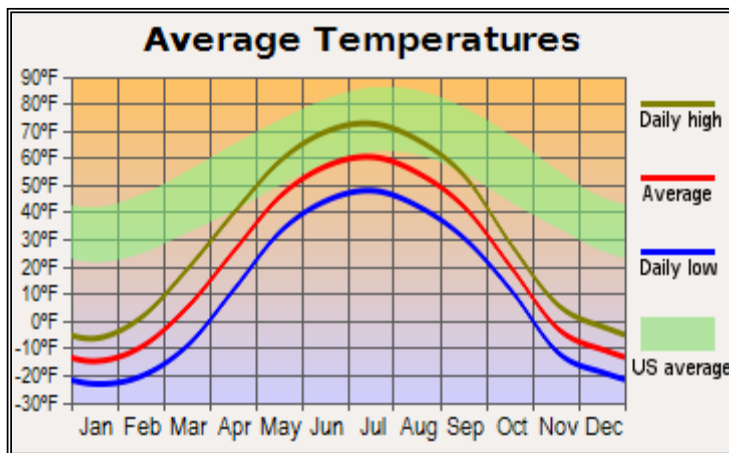
EQUIPMENT RECOMMENDATIONS

<u>Units</u>	<u>Model</u>	<u>Condition</u>	<u>Cost</u>
1	Fecon FTX10L	New	\$115,000
1	Morooka MST	Used	\$ 85,000
1	Takeuchi TB175	Used	\$ 75,000
1	Ford F650	Used	\$ 45,000
2	Stellar Hooklift	New	\$ 50,000
1	Morbark 20 WCL BRUSH CHIPPER	New	\$ 85,000
1	Tractorjet Propulsion Unit	New	\$ 45,000
1	John Deere 350 HP marine engine	New	\$ 38,000
1	Kesla 20SH Stroke harvester	New	\$ 45,000
6	Hooklift Bins	New	\$ 30,000
1	Dymax Tree Shears	New	\$ 12,000
1	Log Grapple	New	\$ 7,500
1	Log/Slash Rake	New	\$ 5,500
1	Fecon Bull Hog Mulcher	New	\$ 19,500
		Total	\$657,500

IV. - Transportation Systems Analysis

Background

A critical element of a sustainable woody biomass fuels program for Fort Yukon is the safe and efficient transport of equipment and wood fuel over the river systems in the project area. The nearly complete lack of road access to the forest resources that will be managed and harvested for this alternative energy program requires the use of these rivers as transportation corridors. In the ice free season this will entail using an appropriately sized landing craft or barge, and in the winter this means hauling cargo over ice.



Fort Yukon Average Monthly Temperatures

The local knowledge base of water and ice conditions has served the community well. The rivers are used regularly for transportation, subsistence, and recreation by the residents of Fort Yukon. Water and ice transportation use however has had very limited application for hauling wood and equipment on an industrial scale. It is vital then, that the local knowledge base is supplemented with a more detailed understanding of how to utilize these rivers for forestry transportation applications in a safe and efficient manner.

This analysis starts this supplementation of knowledge process.

The vastness of the project area precludes an exhaustive analysis of the water and ice conditions for the project area. Significant efforts have been made however to develop an understanding of the major obstacles that may be encountered by a wood fuel project as it gets underway. Over 700 Yukon Flats river miles were traversed in the 2008 summer field season as part of the investigation of summer water conditions for this report. In the past three winters, several field trips have been made on snow machine on the Yukon and Porcupine Rivers in our effort to better understand winter ice conditions in this area.

There are four basic components to a successful wood fuel transportation program:

1. Adequate water depth
2. Adequate ice thickness
3. Proper equipment
4. Effective work force

This analysis addresses the water depth and ice thickness issues.

Ice Free River Water Transportation Analysis

The Yukon River and its tributaries is a major feature of the Yukon Flats landscape. Besides air travel, the communities of this region rely highly on river navigation during the ice free season.

The ice free season begins each year with break up and ends with the formation of skim ice. In most years breakup of the Yukon River ice near Fort Yukon occurs in the second week of May, and skim ice usually begins to develop by mid-September. This effectively defines these 4 months as the annual boat travel season.

Immediately after breakup, the water levels are high as the spring melt develops. Much of the barge travel hauling heavy items and fuel are scheduled for these spring runoff water conditions as they tend to insure adequate water depths in stretches of river that are otherwise comparatively shallow. It is during this time period that follows soon after breakup that heavy loads can be scheduled for transport to much of the project area.



Over 1700 river miles logged in 2008

Generally speaking, the water levels tend to recede throughout summer as the ice and snow melt runoff is exhausted. Some areas that are accessible in the spring become too shallow for navigation for many boats during this period. Storm events can always produce higher water levels at any time during the summer, but this is not certain in terms of occurrence or in its timing.

Consequently, local knowledge of the river channels and routes that remain navigable during the low water period is invaluable. Harvest activities will have to be scheduled with this knowledge in mind.

Production Scheduling Risks during the Ice Free Season

Uncertain water levels are a reality that must be recognized as a major risk to wood fuel production schedules. From a business perspective, a significant disruption or delay in wood fuel production due to inadequate water depths poses a serious and potentially fatal risk to the viability of the whole program. Therefore, it is imperative that methods be employed that reduce these risks to acceptable levels.

Broadly speaking there are two approaches to creating a safe and efficient transportation system for the Fort Yukon woody biomass program. One is to choose equipment that is capable of operating in shallow water, and the other is to identify loading and unloading points both in the village and in the field that have adequate water levels to operate during the dry part of the ice free season. This program will embrace elements of both of these strategies.

Equipment Considerations

In the *Fort Yukon Biomass Harvest Equipment Assessment* portion of this report, significant attention is given to limiting the weight of each piece of equipment to approximately 8 tons. Additionally, that section of this report also describes a landing craft that is capable of handling cargo in the 8 ton range. In order to be truly effective, the landing craft would need to be fitted with a specific type of industrial jet propulsion called a Tractorjet. All of these specifications are designed to maximize the possibilities of operating in low water conditions, while choosing equipment that can still get the harvest responsibilities carried out as efficiently as possible. To exceed the weight specifications set forth for this equipment is to increase the risk of low water conditions interfering with the harvest and delivery of wood fuel to the village in a timely manner.

Loading/Unloading Point Considerations

The rivers in the Yukon Flats region all have shallow segments that pose a risk to safe and efficient wood fuel harvest and transportation. To the extent that it is feasible, loading and unloading points should be selected that minimizes the need to transport cargo over the shallow stretches of river.



Yukon River tributary stop 2008

For the most part, it is anticipated that the main unloading point in Fort Yukon will be in front of the village on the Yukon River. This site is anticipated to work very well whenever cargo comes from across the Yukon River on its south shores or from upriver. Some wood will be produced from stands located along the Porcupine River however. With the main unloading site at the waterfront of the Yukon River at Fort Yukon, the cargo produced on the Porcupine River would have to be hauled to the Porcupine and Yukon River confluence and then upriver to the village. This route would transverse some shallow water areas that could

be avoided if there were an unloading point along the Porcupine River that was connected to the village by road.

Such an unloading point along the Porcupine River exists that is connected to the village by an 8 to 10 mile long unimproved road. With modest improvements to this road and an unloading site established in this area that a hooklift truck could reliably operate on, it is likely that this route could be utilized in most, if not all water levels throughout the ice free season. Consequently, the production risks to low water levels would be greatly reduced or eliminated for wood fuel production from this area.

Other opportunities to reduce the risk of low water restrictions to cargo may also exist for wood fuel produced on the south shore of the Yukon River across from Fort Yukon. The braided nature of the River in this area produces numerous shallow areas that may impede cargo being hauled between these points at low water levels. A closer look at the road options and water

levels along these routes may uncover other potential road and landing configurations that will circumvent these problematic stretches of river as well.

Log Rafting

Assembling wood fuel production into log raft form for transport to the village has attractive possibilities for significant increases in program efficiencies. With the proper boat towing or pushing capacity, several dozen tons of logs could be moved in a single tow resulting in a significant reduction in fuel oil consumption and other hauling costs.

The landing craft discussed in the *Fort Yukon Biomass Harvest Equipment Assessment* portion of this report would be capable of supporting rafting activities. There is however at least two important unknowns at this point in time that tend to discourage log rafting as the chief form of wood transport in the early stages of the program. First is the issue of obtaining any necessary permits for these activities, and the second is determining what volumes of wood lend themselves to be transported in this fashion on an annual basis.

It is important to realize that it will take some time to develop an understanding of the operational issues that come with rafting logs in this area. In the early stages we expect that efforts to get the wood harvest operation to run smoothly using a landing craft for water transport will require all of management's attention. It seems prudent then to defer the complexities of rafting until a time when the operation can better handle the additional responsibilities that come with it.

Winter Hauling and Transport on Ice Analysis



*Drilling ice to measure thickness
Winter 2008*

Hauling cargo over ice is a common practice throughout the Arctic. Oilfield development and other industrial applications have used winter ice conditions to transport equipment and other goods for decades. During this period a considerable amount of useful information and experience has been developed on how to haul on ice efficiently and safely.

Ice travel around Fort Yukon using snowmachine and other light vehicles is common. The local knowledge of ice conditions has served the community well for light travel. The Fort Yukon wood fuel program will need to haul significant volumes of wood fuel over ice in order to meet their production targets. To date, very little heavy hauling has occurred over river ice in this area, and thus there is little local knowledge in this regard.

There are ice thickness records for Fort Yukon that

date back several decades. This data indicates that during certain periods each winter that the ice thicknesses at the point of measurement meet or exceed the required capacity to haul wood fuel safely. Ice strength equations and tables established by the U.S. Army Cold Regions Research and Engineering Laboratory and others correlate ice thickness and other parameters to the ice load carrying capacity. Procedures for measuring thickness and determining ice quality are also given. Properly applied, this information can empower the stakeholders in the Fort Yukon wood energy project with the ability to safely haul wood fuel and equipment over river ice for over three months out of the year.

WHAT YOU NEED TO KNOW ABOUT THE ICE

It is important to use systematic observations of the ice sheet you want to use to support a load. There may be many variations in the structure, thickness, temperature, and strength of a floating freshwater ice sheet.

How thick is the ice?

This is determined by drilling holes with the drill or ice auger. The technique is to drill a hole and check the ice thickness every 150 feet or so along the intended path. This should be done more frequently if the ice thickness is quite variable. Note whether the ice in each hole is clear (sometimes called black ice) or white (due to air bubbles—sometimes called snow ice). Measure the thickness of both kinds.



Winter travel on rivers 2008

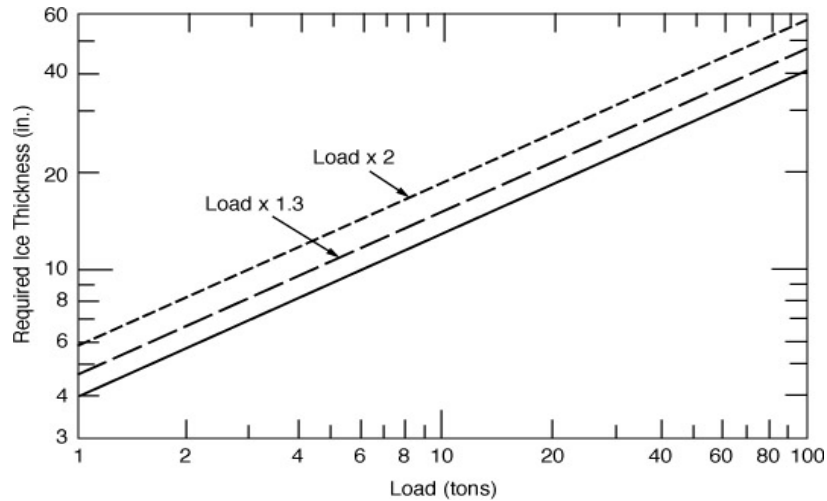
On rivers the ice thickness and quality can change a lot in a short distance; be particularly alert to variations in ice thickness due to bends, riffles or shallows, junctions with tributaries, etc. For both rivers and lakes, warm inflows from springs can create areas of thinner ice. The ice near shores can either be thinner (due to warm groundwater inflow or the insulating effect of drifted snow) or thicker (due to the candle-dipping effect of variable water levels).

Measure the snow cover thickness on the ice cover; significant variations in thickness may mean highly variable ice thicknesses.

How thick does the ice need to be?

A simple formula to estimate the minimum ice thickness required to support a load is $h = 4\sqrt{P}$ where **h** is the ice thickness in inches and **P** is the load, or gross weight, in tons. You can also use

the graph or table to determine the minimum thickness. Remember that the load is the *total* load in tons (not a vehicle's load capacity).



The equation, graph, and table are valid when the load (such as a person on foot, or a wheeled or tracked vehicle) is distributed over a reasonable area of a continuous ice sheet. The larger the load, the greater the area it should cover for the calculation to remain valid. *Neither large loads that are concentrated in relatively smaller areas, nor loads that are at or near the edge of a large opening in the ice, are safely described by the equation, graph, or table.* In such cases, *seek more advice.*

Minimum ice thickness required to support a load		
Load (tons)	Required ice thickness (inches)	Distance between loads (feet)
0.1	2	17
1	4	34
2	6	48
3	7	58
4	8	67
5	9	75
10	13	106
20	18	149
30	22	183
40	26	211

The equation, graph and table assume *clear, sound ice*. If white, bubble-filled ice makes up part or all of the ice thickness, count it as only half as much clear ice.

Basic Procedures of Safety on Ice

- *Never go out on an ice cover alone, and never go out on the ice if there is any question of its safety.*
- While you are planning the outing, obtain the record of air temperature for the past several days and continue observing air temperatures while the ice will be used to support loads.
- Always let someone know of your plans and when you will return.
- When you arrive at the water's edge, visually survey the ice. Look for open water areas, and look for signs of recent changes in water levels: ice sloping down from the bank because the water dropped, or wet areas on the ice because the water rose and flooded areas of the ice that couldn't float because it was frozen to the bottom or the banks. (If the ice is snow-covered, look for wet areas in the snow.)
- Listen for loud cracks or booms coming from the ice. In a river this can mean the ice is about to break up or move; on a lake larger than several acres such noises may be harmless responses to thermal expansion and contraction.
- Look for an easy point of access to the ice, free of cracks or piled, broken ice.
- If you are taking a vehicle or other equipment on the ice, go out on foot first. Vigorously probe ahead of yourself with the ice chisel. If the chisel ever goes through, carefully turn around and retrace your steps back to shore, and try again some other day.
- Near shore, listen for hollow sounds while probing. Ice sloping down from the bank may have air space underneath. This is *not* safe; ice must be floating on the water to support loads.
- After getting on the ice, others in the group should follow in the leader's steps, but stay at least 10 feet apart.
- Only after you have learned the characteristics of the ice cover should any vehicle be taken on the ice.

SAFE OPERATIONS ON THE ICE COVER

If using an enclosed vehicle, *always* drive with the windows or a door open for quick escape.

If you drive across wet cracks, your path should be as close to perpendicular to them as possible, instead of parallel to them.

A load deflects the ice slightly into a bowl shape. When you drive on floating ice, this moving bowl generates waves in the water. If the speed of the waves equals the vehicle speed, the ice-sheet deflection is *increased* and the ice is much more likely to break. The problem is more serious for thin ice and shallow water. In general you avoid this danger by driving below 15 mph.

When there are two loads on the ice, the safe distance between them is about 100 times the ice thickness at the required minimum thickness. This is shown in the third column of the table. When the two loads are different, choose the spacing shown for the larger load. At ice thicknesses greater than the required minimum, this spacing can be reduced.



A loaded ice sheet will creep, or deform, over a long period of time, *without any additional load*. If an ice sheet has to be loaded for a long period, drill a hole near the load. If the water begins to flood the ice through the hole, move the load *immediately*. Remember this if your vehicle ever becomes disabled: if left for a few days, it may break through the ice as a result of long-term creep.

Equipment and Loading/ Unloading Point Considerations

There are similarities between hauling on ice and over water. Both are concerned with the weight of the cargo and water/ice conditions. Weight limitations for equipment and cargo also apply for hauling over ice as they do for water transportation. Production scheduling risks of hauling over river ice due to inadequate ice thickness also exist. In both cases, the strategies employed in hauling over water apply in similar manner to hauling on ice.

All of the equipment utilized in the summer months will also be used in the winter production period. The weight limitations imposed by the capacity of the landing craft are within acceptable parameters for ice hauling. For example, an 8 ton machine will need less than 13 inches of clear, sound, floating ice in order to safely transit on according the ice strength table. Ice thicknesses exceeding this amount are common over much of the project area for 3 or more months of the year according to historical records. Thus, the machine weights we are anticipating are not expected to be a limiting factor for hauling over ice.

Wood fuel loads are anticipated to be hauled on and towed from the field with the Morooka vehicle. Heavier loads are desired whenever possible in order to haul more wood fuel per trip

and thus reduce the number of trips necessary to meet production goals. A simple system of placing hooklift containers loaded with wood chips or stick firewood can be placed on simple sleds and towed in tandem behind the Morooka. With this system the entire load weight can be regulated by the number of sleds being towed and the distance between each one in order to comply with the maximum load capacity of the ice being traversed.

Establishing safe routes to cross a river on ice is another strategy that has the capacity to reduce risk and increase efficiency. By limiting the distance equipment and wood fuel is hauled over ice, the risk of an accident or production interruption due to inadequate ice thickness can be managed.

A single crossing over a relatively short stretch of river can more easily be monitored for safe ice conditions than longer stretches over river segments that may have varying ice thicknesses and quality. Ice thickness can also be managed on a specific crossing site fairly readily by employing ice road construction and maintenance techniques that will increase ice thickness. Obviously this is an easier task for a 200 yard river crossing than a 10 mile long river route.

Hauling across stretches of ice that the operator is highly confident of its capacity to support the load weights is vital to the entire operation. Consistent load weights being systematically traversing carefully monitored and managed ice crossings is vital to the long term success of the Fort Yukon Wood Fuel Program.

V. - Contract Agreement Formulation

Background

A number of villages throughout Alaska have the potential to harvest woody biomass from their own local lands to displace tens of thousands of gallons of diesel heating oil annually. In order for this effort to make a significant impact on the cost of heating residential and commercial buildings in a given community, the program necessarily has to occur on a commercial scale. As a result, the wood fuel program has to have widespread support throughout the community, and the community must make a conscious choice to embrace wood fuel as an alternative energy source.

Establishing a fundamentally solid new business enterprise will be a very challenging task in much of rural Alaska. It is essential that each step taken add to the confidence of the stakeholders in the project. One such step is to provide the community, in this case Fort Yukon, with template legal agreements. While each community will have its own unique set of circumstances that will require modifications to these templates, it is very helpful for the village to have a framework from which they can begin their discussions and planning.

Two contract templates are provided here, a *Harvest Contract* and a *Biomass Purchase Contract*.

The Harvest Contract defines the relationship between the harvest company and the timber owner. In some instances, and as is anticipated to be the case in Fort Yukon, the Village Corporation will also be the entity generally responsible for harvesting the woody biomass. In such cases it is advisable to have a subsidiary of the Village Corporation conduct the harvest operations rather than the Corporation itself for liability exposure management reasons.

This Harvest Contract template covers most terms that are anticipated and which need to be addressed between the Harvest Company and the timber owner. It is important to appreciate that this is a template however and it is not intended to cover all possible issues that a specific operation may need to consider. There may be any number of details which both the Harvest Company and Timber Owner may deem necessary which they will need to take the responsibility of drafting into this template agreement.

The Biomass Purchase Contract identifies the terms of sale between the wood fuel distributor and the consumer. A contract is necessary here since in many cases the agreement will be for more than one year. A contract gives some legal assurances that the fuel will be provided and on terms specified in the contract. This is intended to add confidence to both the distributor and the consumer that each party is committed to the program and as such both can make investments into the program.

VI. - Appendices

Appendix A	BIOMASS HARVEST AGREEMENT
Appendix B	BIOMASS HARVEST AGREEMENT EXHIBITS
Appendix C	FEEDSTOCK SUPPLY AGREEMENT
Appendix D	ICE DATA
Appendix E	HARVEST EQUIPMENT ALTERNATIVE CONFIGURATION

Appendix A

BIOMASS HARVEST AGREEMENT

THIS AGREEMENT is entered into as of the ___ day of _____, 200__ by and between _____ an Alaska for profit corporation (“Landowner”) and _____ an Alaska _____ (“Distributor”).

W I T N E S S E T H:

WHEREAS, Landowner owns the surface estate of certain lands near the community of _____ in the State of Alaska (“Community”); and

WHEREAS, the Landowner’s lands have significant amounts of Biomass (as hereinafter defined) located on them; and

WHEREAS, Distributor is commencing a business in the Community of providing Biomass as a renewable alternative energy source to petroleum products for certain uses; and

WHEREAS, Distributor wishes to acquire the right to harvest the Biomass from Landowner’s lands; and

WHEREAS, the parties have reached an agreement as to the terms under which Distributor may harvest the Biomass from Landowner’s lands, and wish to memorialize their agreement.

In consideration to the mutual promises contained herein, the receipt and sufficient of which is hereby acknowledged, the Parties covenant and agree as follows:

1. Grant of Harvest Rights

Subject to the terms and conditions set out herein, Landowner hereby grants to Distributor the exclusive right to harvest and remove the Biomass from those lands described in Exhibit A, attached hereto and incorporated herein by reference (“Lands”). As used herein, the term “Biomass” shall mean all vegetation, living or dead, which in the judgment of Distributor is capable of being converted to energy by Distributor, including but not limited to timber, brush, downed trees and fire damaged trees. The parties acknowledge that Distributor may also harvest certain standing timber for resale by it as lumber or house logs (“Unprocessed Timber”).

In conducting its harvest and other operations upon the Lands, Distributor shall comply with the Special Limitations set out in Exhibit B, attached hereto and incorporated herein by reference.

2. Price and Payment

The price of the Biomass and Unprocessed Timber harvested and removed from the Lands will be calculated in the manner set out in Exhibit C, attached hereto and incorporated herein by reference. Such amount shall be based initially on the volume of the chipped Biomass and the volume measured by cords of the Unprocessed Timber, at the time each is shipped from the Lands (“Base Payment”). Distributor shall assume the risk of loss for the Biomass and Unprocessed Timber upon its removal from the Lands.

The Base Payment for such Biomass and Unprocessed Timber shall be made (i) on or before August 1st for that Biomass and Unprocessed Timber removed from the Lands after December 31st and before July 1st, and (ii) on or before February 1st for that Biomass and Unprocessed Timber removed after June 30th and before January 1st.

The Base Payment for the Biomass shall be adjusted based upon its BTU Content in the manner described in Exhibit C (“BTU Adjustment”). The amount of the BTU Adjustment shall be paid on or before September 1st of each year for Biomass removed from the Lands after June 30th of the preceding year and before July 1st of the year in which such payment is made.

All payments made pursuant to this Section 3 shall be made to Landowner at its address set forth herein or by wire transfer to such account as may be designated by Landowner. Each such payment shall be accompanied by a detailed report setting forth the calculation of the payment (“Payment Report”). In the event of a wire transfer, the Payment Report will be sent to the Landowners’ address as of the date the payment is made.

3. Operations Plans

a. Operational Standards. Distributor will cause its operations under this Agreement to be conducted in conformity with the Operational Standards set forth in Exhibit D, attached hereto and incorporated herein by reference (“Operational Standards”). In addition to the Operational Standards, the operations of Distributor hereunder will be conducted in full compliance with all applicable federal, state and local laws and regulations.

b. Permitting. Distributor will be responsible for securing at its sole cost and expense all permits and authorizations, including without limitation, those issued by the Army Corps of Engineers and other federal and state agencies, which are required for Distributor and its contractors to conduct the activities contemplated by this Agreement.

c. Five Year Plans. Within one (1) year following the execution of this Agreement, Distributor shall submit its initial plan for its first five (5) years of operations hereunder (“Five Year Plan”) and shall submit annual amendments to such plan prior to the commencement of each year of the plan. In addition, each Five Year Plan shall address the items described in Exhibit E, attached hereto and incorporated herein by reference.

Distributor shall submit a Five Year Plan for each five year period during the term of this Agreement; provided, however, the plan submitted for the remaining balance of the initial term or of the extension of the Agreement may be for less than five (5) years. Such subsequent Five Year Plans shall be submitted by June 1st of the fourth calendar year of the proceeding plan.

d. Annual Harvest Plans. By August 1st of each year, Distributor will submit to Landowner its Annual Harvest Plan for the next calendar year. Such plan shall be specific as to the areas to be harvested, the volume and specie to be taken, the transportation routes, time for harvest and means of harvesting and transporting the Biomass. Such plan shall also set out the number of employees to be employed; their positions and the location and description of their housing at the job site.

The Annual Harvest Plan shall also include such revisions and amendments to the Five Year Plan as Distributor may determine to be needed. Where appropriate, the Annual Harvest Plan shall also describe the reforestation activities to be undertaken during that year and other activities required under the State of Alaska's Forest Practices Act ("Act").

4. Term

The initial term of this Agreement shall be for a period of ten (10) years commencing upon first day of the first Five Year Plan. If Distributor is not in breach hereof, such term may be extended by Distributor for another ten (10) years upon written notice to Landowner which notice shall not be given later than two hundred ten (210) days prior to the end of the tenth (10th) year of the initial term.

5. Forest Practices Act

The operations of Distributor and its contractors and agents hereunder shall be in compliance with the provisions of the ("Act") as amended from time to time. Distributor shall provide prompt notice to Landowner of any violation of the Act and the action taken to remedy the violation.

Distributor shall conduct reforestation/revegetation programs of the harvested areas of the Lands which will result a sustained yield of Biomass equal to or in excess of that on the Lands at the time of the harvest. Distributor shall submit such program to Landowner as part of its first Five Year Plan and shall update it in each Five Year Plan thereafter.

Distributor shall also comply fully with the reforestation and revegetation requirements of the Act and in the third year of the term of this Agreement commence to engage in the required reforestation of the Lands. Commencing in the sixth year of the initial term, Distributor shall create a fund to be expended only upon reforestation and compliance with the reclamation provisions of the Act and set aside in such fund an annual amount mutually agreed upon by the parties, the sum of which annual amounts for the remaining years of the initial term would be sufficient to pay for the reforestation and reclamation work required by the Act. Landowner shall have the right to audit such fund and any payments made from it.

6. Landowner's Right to Inspect

At all reasonable times during Distributor's operations, Landowner shall have access to the Lands for the purpose of inspection of the operations of Distributor and its contractors, and for purpose of posting notices of non-responsibility, so long as activities by Landowner does not unreasonably interfere with Distributor's operations.

Landowner shall hold Distributor and its contractors harmless from any injury or loss arising from Landowner's activities on the Lands.

7. Designation of Other Lands.

The Parties recognize that it may be advantageous to Landowner and Distributor for Distributor to harvest areas which have been subject to wildfires. Should, during the term of this Agreement and any extensions thereof, a wildfire occurs on lands belonging to Landowner, other than the Lands, the Parties shall explore whether the harvest of the Biomass from such burned over area during the remaining term of this Agreement is mutually advantageous and if so, what, if any, additional Special Limitations are required or be applied to such area.

Should the Parties reach an agreement to include such burned over area under this Agreement, then the Parties shall enter into an amendment to this Agreement.

8. Book and Records.

Distributor shall maintain or cause to maintain records regarding the operations under this Agreement, including but not limited to harvest records regarding the specie and volume harvested, the BTU measurements for the harvested Biomass, the dates of the harvest and shipments of the biomass and all other information necessary to enable Landowner to calculate the Base Payment and the BTU Adjustment. Such records shall be available to Landowner or its designated representative at the Distributor's principal office for examination and copying.

Should Landowner request an audit of the records to determine the correctness of any payment made to it hereunder, such audit shall be performed at Landowner's sole cost and expense; provided, however, should the audit disclose that such payment is five percent (5%) or more, less than the amount that it should be, then Distributor shall pay the amount of the underpayment plus interest thereon, as well as reimburse Landowner for its costs for the performance of the audit of the records. Such payments shall be made by Distributor within sixty (60) days of the completion of the audit and its delivery by Landowner to Distributor.

9. Insurance and Indemnification.

Distributor shall defend, indemnify and save harmless Landowner from and against any and all claims, demands and causes of action by any nature whatsoever, and from and against any expenses incident thereto or incurred by Landowner as a result thereof, for any injury to or death of persons or loss of or damage to property or economic losses occurring on the Lands, or in any manner arising out of the performance or lack of performance of the operations by Distributor or its contractors, during the term or any extended term of this Agreement; provided, however, that Distributor shall not be required to defend, indemnify or save Landowner harmless from claims, demands or causes of action to the extent the same are caused by Landowner's own intentional or negligent acts or omissions. Distributor shall procure and maintain commercial general insurance coverage, naming Landowner as an additional

insured which coverage shall not be less than \$2,000,000 per person, \$3,000,000 in aggregate per accident, and \$2,000,000 property damage; with no less than \$5,000,000 in excess or umbrella coverage. Such coverage shall be endorsed to be primary and non-contributing to any coverage maintained by Landowner respectively and shall be issued by insurance companies licensed to do business in the state of Alaska with general policyholder's ratings of at least A- and a financial rating of at least VII in the most current Bests Insurance Reports available on the renewal date of the insurance coverage. Distributor agrees to furnish copies of certificates evidencing insurance coverage to Landowner automatically, without demand of Landowner. It is understood and agreed that procurement and maintenance of the commercial general liability insurance required by this provision does not supersede, extinguish or discharge Distributor's duties to defend, indemnify and save harmless Landowner under the first sentence of this provision or any other Section of this Agreement. Distributor shall also carry or cause to be carried all workers' compensation insurance on its employees and the employees of its contractors.

10. Representations and Warranties.

a. By Landowner

Landowner represents and warrants to Distributor as follows:

- (i) Landowner is a for profit corporation duly authorized and validly existing under the laws of the State of Alaska, with full corporate power and authority to execute and deliver this Agreement and perform its obligations hereunder. This Agreement constitutes the valid and legally binding obligation of Landowner enforceable in accordance with its terms.
- (ii) Landowner is the owner of the Lands. The Lands are not encumbered and Landowner has the full power and authority to

grant to Distributor the interests in such Lands as is provided in this Agreement.

- (iii) Neither the execution and delivery of this Agreement nor the performance by Landowner of its obligations hereunder (A) violates any provision of the Articles of Incorporation or Bylaws of Landowner or (B) will conflict with, result in a breach of, constitute a default under, result in the acceleration of, or require notice under any agreement, contract, lease, license or other agreement to which Landowner is a party or by which it is bound which would cause Landowner to be unable to consummate the transactions contemplated by this Agreement.

b. By Distributor.

Distributor represents and warrants to Landowner as follows:

- (i) Distributor is a _____, duly organized and validly existing under the laws of the State of Alaska; with full power and authority to execute and deliver this Agreement and to perform its obligations hereunder. This Agreement constitutes the valid and legally binding obligation of Distributor enforceable in accordance with its terms and conditions.
- (ii) Neither the execution and delivery of this Agreement nor the performance by Distributor of its obligations hereunder (A) violates any provision of the (Articles of Incorporation) or (Bylaws) of Distributor or (B) will conflict with, result in a breach of, constitute a default under, result in the acceleration of or require notice under any agreement, contract, lease, license or other agreement to which Distributor is a party or by which it is bound,

which would cause Distributor to be unable to consummate the transactions contemplated by this Agreement.

11. Default

a. A Party is in default hereunder upon the occurrence of any of the following:

- (i) if a Party (“Defaulting Party”) at any time during the term of this Agreement shall fail to make payment required hereunder within fifteen (15) days after such payment is due; or
- (ii) if a Party (“Defaulting Party”) fails to observe or perform any of such Party’s other material covenants, agreements or obligations hereunder, and if within thirty (30) days after a non-defaulting Party shall have given to the Defaulting Party written notice specifying such failure or failures, Defaulting Party shall not have commenced to correct the same and proceed diligently to correct the same, or proceeded in accordance with Section 11(b) below, if applicable; or
- (iii) The filing of a petition, by or against a party (“Defaulting Party”), for adjudication as a bankrupt under the Bankruptcy laws, now or hereafter amended or supplemented, or for reorganization within the meaning of Chapter X of said Bankruptcy laws or the filing of any petition by or against the Defaulting Party under any future bankruptcy act for the same or similar relief; or
- (iv) The making by a Party (“Defaulting Party”) of an assignment for the benefit of creditors.

b. In the event of a Default, the non-defaulting Party may give notice of the Default to the Defaulting Party and the Defaulting Party shall have thirty (30) days to commence a cure. If no cure is commenced and timely pursuant then the non-Defaulting Party may give notice of its election to pursue immediate mediation of the issue or to terminate this Agreement thirty (30) days from the issuance of the notice. If the Parties engage in mediation of the issue and are unable to reach a satisfactory settlement, then the non-Defaulting Party shall have the right to terminate this Agreement on fifteen (15) days written notice to the Defaulting Party. Nothing in this Section 11(b) shall limit the non-Defaulting Party's right to seek compensation for any injury or damage to it caused to it by the Default.

12. Rights or Remedies.

Except insofar as is inconsistent with or contrary to any provisions of this Agreement, no right or remedy herein conferred upon or reserved to a Party is intended to be exclusive of any other right or remedy and each and every right and remedy shall be cumulative and in addition to any other right or remedy given hereunder, or now, or hereafter existing at law or in equity or by statute.

13. Reports.

Distributor shall submit to Landowner detailed written reports regarding its activities on the Lands, in a form and substance satisfactory to Landowner. Such reports shall be submitted on a monthly basis by the tenth (10th) day of the month following the month which is the subject of the report. Distributor shall immediately inform Landowner by phone or radio communication, followed up by a written report, of any serious injury to person or property which occurs on the Lands during the course of its operations.

14. Assignment.

This Agreement may not be assigned in whole or in part by any party hereto. Distributor may subcontract the harvest operations hereunder upon the prior written notice to

Landowner. Distributor will submit to Landowner the proposed subcontract, the qualifications and financial capabilities of the proposed subcontractor. Such subcontractor shall carry the insurance required hereunder and shall have previous experience in performing tasks similar to that to be performed under this Agreement. No subcontract of this Agreement will relieve Distributor from its obligations hereunder.

15. Notices.

All notices, requests, demands, claims and other communications required or permitted hereunder will be in writing. Any notice, request, demand, claim or other communication hereunder shall be deemed duly given if (and then two business days after) it is sent by registered or certified mail, return receipt requested, postage prepaid, and addressed to the intended recipient as set forth below:

To Landowner:

Attn: President

Fax: _____

To Distributor:

Attn: President

Fax: _____

Either party may send any notice, request, demand, claim, or other communication hereunder to the intended recipient at the address set forth above using any other means (including personal delivery, expedited courier, messenger service, telecopy, telex, ordinary mail, or electronic mail), but no such notice, request, demand, claim or other communication shall be deemed to have been duly given unless and until it actually is received by the intended recipient. Any party may

change the address to which notices, requests demands, claims and other communications hereunder are to be delivered by given the other party notice in the manner herein set forth.

16. Waiver and Forbearance.

No waiver by one party of any breach by the other party of any of its obligations, agreements or covenants hereunder, shall be deemed to be a waiver of any subsequent breach of the same or any other covenant, agreement or obligation. Nor shall any forbearance by a party in seeking a remedy for any breach of the other party be deemed a waiver by the non-breaching party of its rights or remedies with respect to such breach.

17. Miscellaneous.

a. Governing Law. This Agreement shall be governed by and interpreted in accordance with Alaska law.

b. Forum Selection and Mediation. Any lawsuit brought by either Party to enforce, interpret or apply this Agreement may only be brought in a court of competent jurisdiction in Anchorage, Alaska. The Parties hereby consent to the exclusive jurisdiction and venue of such court. The Parties further agree that, except as otherwise provided herein, prior to the instigation of a lawsuit between them, the Parties shall attempt to resolve their dispute by non-binding medication. Such mediation shall occur in _____, Alaska within fifteen (15) days of the date on which either party requests mediation. The Parties shall jointly select the mediator and shall equally bear the expense of the mediator.

c. Interpretation and Severance. The Parties acknowledge that this Agreement is the result of negotiations between them and both agree that the rule of interpreting contracts against the party drafting the same shall not apply to this Agreement. The unenforceability, invalidity or illegality of any provision of this Agreement shall not render any other provisions unenforceable, invalid or illegal.

d. No Partnership. Nothing herein is intended to create any partnership or joint venture between the Parties. The Parties hereby expressly disclaim any partnership or joint venture relationship between them.

e. Integration and Modification.

(i) This document contains the final entire agreement of the parties hereto. All negotiations, statements, representations, warranties, and assurances, whether oral or written, which are in any way related to the subject matter of this Agreement and the performance of either party hereto are merged and integrated into the terms of this document.

(ii) This Agreement may not be modified nor amended except by a writing signed by both parties hereto, and any purported amendment or modification is without effect until reduced to a writing signed by both parties hereto.

f. Force Majeure. Except for Distributor's obligation to make monetary payments, the obligations of Distributor hereunder shall be superseded so long as and to the extent that it is prevented or hindered from complying herewith in whole or in part by circumstances beyond its reasonable control, including without limitation, acts of God or public enemy; fire; labor disturbances; strikes; riots; insurrections; civil commotion; storms; earthquakes; lack of suitable facilities or equipment due to damage, shortage of or inability to obtain materials or equipment, or to obtain transportation therefore; laws, rules, and regulations of any governmental agency or authority, including acts of governmental agencies delaying or preventing the issuance of permits necessary to conduct activities envisioned under or required by this Agreement; or any other cause beyond their control, whether similar or dissimilar to those herein specifically enumerated. After the removal of the cause or causes preventing or hindering the performance of the obligation, Distributor shall diligently commence or resume the performance of such obligation. Any period or periods of time Distributor is delayed or hindered

in the conduct of operations envisioned under or required by this Agreement due to force majeure shall be added to and so extend any period for action under this Agreement as well as the term of this Agreement.

g. Time of Performance. Time is of the essence in the Parties performance of their obligations hereunder.

h. Short Form Recordation. The Parties agree to execute and acknowledge a short form memorandum of this Agreement in a form which is suitable for recording. Upon the termination of this Agreement, the Parties shall execute a memorandum suitable for recording reflecting such termination or release.

DATED as of this _____ day of _____, 20_____.

LANDOWNER

By: _____

Its President

DISTRIBUTOR

By: _____

Its President

ACKNOWLEDGEMENT

STATE OF ALASKA)
) ss
 _____ JUDICIAL DISTRICT)

THIS IS TO CERTIFY that on this ___ day of _____, 20___, before me, the undersigned Notary Public in and for the State of _____, duly commissioned and sworn, personally appeared _____, to me known and known to be the _____ of _____, and known to me to be the person who signed the foregoing instrument on behalf of said corporation, and he acknowledged to me that he signed and sealed the same as the free act and deed of said corporation for the uses and purposes therein expressed pursuant to its Bylaws or a resolution of its Board of Directors.

WITNESS my hand and official seal on the day and year in this certificate first above written.

Notary Public in and for Alaska
My Commission Expires: _____

ACKNOWLEDGEMENT

STATE OF ALASKA)
) ss
 _____ JUDICIAL DISTRICT)

THIS IS TO CERTIFY that on this ___ day of _____, 20___, before me, the undersigned Notary Public in and for the State of _____, duly commissioned and sworn, personally appeared _____, to me known and known to be the _____ of _____, and known to me to be the person who signed the foregoing instrument on behalf of said corporation, and he acknowledged to me that he signed and sealed the same as the free act and deed of said corporation for the uses and purposes therein expressed pursuant to its Bylaws or a resolution of its Board of Directors.

WITNESS my hand and official seal on the day and year in this certificate first above written.

Notary Public in and for _____
My Commission Expires: _____

Appendix B

Exhibit A

(Attached to and Part of that certain Biomass
Harvest Agreement dated _____, 20__)

LANDS

The following described lands are the “Lands” subject to the terms of this Agreement.

[Insert Legal Description of Lands]

Exhibit B

(Attached to and Part of that certain Biomass
Harvest Agreement dated _____, 20__)

SPECIAL LIMITATIONS ON LANDS

Insert special limitations on the Lands such as

- Cultural Areas
- Areas of special subsistence use
 - Hunting
 - Trapping
 - Gathering activities
- Other limitations which are of a concern to the community.

Exhibit C

(Attached to and Part of that certain Biomass
Harvest Agreement dated _____, 20__)

CALCULATION OF BASE PAYMENT
AND BTU ADJUSTMENT

Base Payment.

Insert schedule for calculation of the Base Payment.

For chipped Biomass create a matrix by specie and volume and price per volume unit.

For Unprocessed Timber create a matrix by specie size (base diameter) by price per cord
volume.

Set out possible adjustment mechanism to the Base Payment to reflect current pricing at
various times during the life of the Agreement.

BTU Adjustment

Structure a mechanism to reflect a matrix relating an incentive for payment for the Biomass which is based upon the BTU per ton or volume unit of the Biomass.

No such adjustment is made for Unprocessed Timber.

Exhibit D

(Attached to and Part of that certain Biomass
Harvest Agreement dated _____, 20__)

OPERATIONAL STANDARDS

Insert standards to be met by Distributor and its Contractors for their operations on the Lands. These should reflect operational considerations based upon the conditions of the Land and the concerns of the community. These include:

1. General Standards.
 - preservation of the health of the forest
 - maintain and preserve the ecological status of the Lands
 - conduct operations so that they have positive impact on wildfire management
 - conduct operations in manner to minimize wildfire; harvest useable Biomass from burned over areas and stimulate regeneration in such areas.
 - complying with all applicable laws and regulations
 - conduct operations in conformity with best industry practices
2. Specific Considerations
 - time for harvest
 - minimize impact on subsistence activities
3. Access Limitations
 - access corridors
 - modes of transportation
 - designated loading and processing (chipping) areas
 - seasonal limits on transportation
4. Equipment Limitations
 - limit size/weight of equipment
 - 15,000 to 20,000 lbs. maximum weight
 - minimize impact on surface
5. Employment and Training
 - steps to be taken to train and employ local residents in the harvest of Biomass and its use in the community.

Exhibit E

(Attached to and Part of that certain Biomass
Harvest Agreement dated _____, 20__)

FIVE YEAR PLANS

Five Year Plan to address the following matters:

1. Description of Operations to be conducted during the five year period
 - the Lands to be utilized,
 - the access routes and loading points,
 - the modes of transportation to be used,
 - the time operations to be conducted
 - volume to be harvested
2. The permits to be secured and the process to be followed to secure them (a copy of the applications for such permits shall be provided to Landlord).
3. Manner in which the Operational Standards will be followed.
4. General plans for conducting reforestation, revegetation and remediation in a manner to result in a sustained yield of Biomass.
5. Description of the program to be implemented for the training and employment of the local resident and goals for the number of persons to be employed under the program.

Appendix C

FEEDSTOCK SUPPLY AGREEMENT

THIS AGREEMENT is entered into as of the ____ day of _____, 20__, by and between _____ an Alaska for profit corporation (“Distributor”) and _____ an Alaska _____ (“Customer”).

WITNESSETH:

WHEREAS, Customer has a biomass plant for the generation of heat and power (“Plant”) for use by its business; and

WHEREAS, Customer requires biomass to use in its plant (“Feedstock”) to generate heat and power; and

WHEREAS, Distributor harvests vegetative biomass and supplies it to owners of biomass plants for use as fuel in their plants; and

WHEREAS, Distributor and Customer have reached an agreement as to the terms under which Distributor will supply Customer with Feedstock for its Plant, and wish to memorialize their agreement; therefore,

In consideration of the mutual promises contained herein, the receipt and sufficiency of which is hereby acknowledged, the Parties covenant and agree as follows:

1. Purchase and Sale of Feedstock

Subject to the terms contained herein, Distributor agrees to sell, furnish and deliver to Customer and Customer agrees to purchase, and receive from Distributor

Feedstock. Such Feedstock shall meet the specifications set out in Exhibit A, attached hereto and incorporated herein by reference. Customer acknowledges that Feedstock, which meets the specifications, is suited of use in Customer's plant for the generation of heat and power.

Distributor shall provide Feedstock each month in the volumes described in Exhibit B, attached hereto and incorporated herein by reference. Distributor and Customer shall agree upon the schedule for the delivery of Feedstock, which schedule shall be memorialized in writing and may be amended from time to time by the parties. Customer acknowledges it will use its best efforts in developing the schedule to reflect its seasonal needs and to assure that it has a reserve which it considers to be appropriate should deliveries be delayed because of weather conditions or equipment failure.

Exhibit B may be amended by the Parties from time to time to adjust the volumes of Feedstock to be sold to Customer. The Customer recognizes that the harvest of the biomass for Feedstock generally occurs in the summer and that Distributor's uncommitted inventory of Feedstock from September 1st to June 1st ("Winter Period") may not be sufficient to provide for increases in volume to Customer. Distributor will make all reasonable efforts to honor a request for an increase in the volume made during Winter Period. However, Distributor reserves the right to adjust the price for such increase in the volume to be delivered within such Winter Period, to reflect any additional costs which it may incur to obtain the increased volume. A minimum of ninety (90) days is required before any increase in the volume becomes effective.

2. Delivery of Feedstock

Subject to the terms of this Agreement, Distributor shall deliver to Customer's Plant, Feedstock in the volumes and at the times specified in Exhibit B. Customer shall provide a dry storage area for Feedstock delivered by Distributor. Such storage area shall meet the requirements identified by Company to be necessary to maximize the BTU of the Feedstock.

3. Price and Payment

The price of the delivered Feedstock shall be calculated in the manner set out in Exhibit C. Customer shall be billed on a calendar month basis for all Feedstock delivered to Customer during such month. Such amount is hereinafter referred to as the Base Price. Payment for the Base Price is due within fifteen (15) days of the date of the invoice.

The Base Payment of the Feedstock shall be adjusted based upon the actual BTU content of the Feedstock utilized by Customer. The BTU content shall be equal to the BTU's generated by the conversion of the Biomass by Customer's Plant which BTU's shall be determined by the monitoring equipment connected to Customer's Plant. The amount of the BTU's generated shall be calculated for each calendar quarter in the manner set out in Exhibit C. Such amount is hereinafter referred to as the Adjusted Price.

Distributor shall invoice Customer at the end of the calendar quarter for the Adjusted Price less the Base Price paid during such quarter. Should the Base Price for the calendar quarter exceed the Adjusted Price, then Customer shall be given a credit for the difference. Should the Adjusted Price exceed the Base Price for the quarter, Customer shall pay the difference within fifteen (15) days of the date of the invoice. All amounts not timely paid hereunder, irrespective of whether they are for the Base Price or the Adjusted Price shall bear interest at the rate of one and one-half percent (1 ½%) from the date of the invoice.

4. Maintenance of Plant

Customer shall maintain the Plant and feeding mechanism in good operating condition. Distributor shall have the right to monitor and test the instruments measuring the BTU's generated by the Plant. At Distributor's option, Distributor may install its own instruments to measure the BTU's generated. Distributor shall maintain a

record of all maintenance performed on the BTU measurement instruments, the readings taken from such instruments and the Feedstock delivered to Customer by date delivered and the locate of its harvest.

5. Term

The initial term of this Agreement shall be for a period of ____ years, commencing upon the first day of the month during which a delivery of Feedstock is made to Customer. This Agreement may be terminated by either party hereto upon one year's written notice.

6. Insurance and Indemnification.

Distributor shall defend, indemnify and save harmless Customer from and against any and all claims, demands and causes of action by any nature whatsoever, and from and against any expenses incident thereto or incurred by Customer as a result thereof, for any injury to or death of persons or loss of or damage to property or economic losses occurring at Customer's Plant site arising out of the operations by Distributor or its contractors, during the term or any extended term of this Agreement; provided, however, that Distributor shall not be required to defend, indemnify or save Customer harmless from claims, demands or causes of action to the extent the same are caused by Customer's own intentional or negligent acts or omissions. Distributor shall procure and maintain commercial general insurance coverage, naming Customer as an additional insured which coverage shall not be less than \$2,000,000 per person, \$3,000,000 in aggregate per accident, and \$2,000,000 property damage; with no less than \$5,000,000 in excess or umbrella coverage. Such coverage shall be endorsed to be primary and non-contributing to any coverage maintained by Customer respectively and shall be issued by insurance companies licensed to do business in the state of Alaska with general policyholder's ratings of at least A- and a financial rating of at least VII in the most current Bests Insurance Reports available on the renewal date of the insurance coverage. Distributor agrees to furnish copies of certificates evidencing insurance

coverage to Customer automatically, without demand of Customer. It is understood and agreed that procurement and maintenance of the commercial general liability insurance required by this provision does not supersede, extinguish or discharge Distributor's duties to defend, indemnify and save harmless Customer under the first sentence of this provision or any other Section of this Agreement. Distributor shall also carry or cause to be carried all workers' compensation insurance on its employees and the employees of its contractors.

7. Representations and Warranties.

a. By Customer

Customer represents and warrants to Distributor as follows:

- (i) Customer is a _____ corporation duly authorized and validly existing under the laws of the State of Alaska, with full power and authority to execute and deliver this Agreement and perform its obligations hereunder. This Agreement constitutes the valid and legally binding obligation of Customer enforceable in accordance with its terms.
- (ii) Customer is the owner and operator of the Plant. The Plant is not leased to any third party.
- (iii) Neither the execution and delivery of this Agreement nor the performance by Customer of its obligations hereunder (A) violates any provision of the Articles of Incorporation or Bylaws of Customer or (B) will conflict with, result in a breach of, constitute a default under, result in the acceleration of, or require notice under any agreement,

contract, lease, license or other agreement to which Customer is a party or by which it is bound which would cause Customer to be unable to consummate the transactions contemplated by this Agreement.

b. By Distributor.

Distributor represents and warrants to Customer as follows:

- (i) Distributor is a for profit corporation, duly organized and validly existing under the laws of the State of Alaska; with full power and authority to execute and deliver this Agreement and to perform its obligations hereunder. This Agreement constitutes the valid and legally binding obligation of Distributor enforceable in accordance with its terms and conditions.
- (ii) Neither the execution and delivery of this Agreement nor the performance by Distributor of its obligations hereunder (A) violates any provision of the Articles of Incorporation or Bylaws of Distributor or (B) will conflict with, result in a breach of, constitute a default under, result in the acceleration of or require notice under any agreement, contract, lease, license or other agreement to which Distributor is a party or by which it is bound, which would cause Distributor to be unable to consummate the transactions contemplated by this Agreement.

8. Default

a. A Party is in default hereunder upon the occurrence of any of the following:

- (i) if a Party (“Defaulting Party”) at any time during the term of this Agreement shall fail to make payment required hereunder within fifteen (15) days after such payment is due; or
- (ii) if a Party (“Defaulting Party”) fails to observe or perform any of such Party’s other material covenants, agreements or obligations hereunder, and if within thirty (30) days after a non-defaulting Party shall have given to the Defaulting Party written notice specifying such failure or failures, Defaulting Party shall not have commenced to correct the same and proceed diligently to correct the same, or proceeded in accordance with Section 8(b) below, if applicable; or
- (iii) The filing of a petition, by or against a party (“Defaulting Party”), for adjudication as a bankrupt under the Bankruptcy laws, now or hereafter amended or supplemented, or for reorganization within the meaning of Chapter X of said Bankruptcy laws or the filing of any petition by or against the Defaulting Party under any future bankruptcy act for the same or similar relief; or
- (iv) The making by a Party (“Defaulting Party”) of an assignment for the benefit of creditors.

b. In the event of a Default, the non-defaulting Party may give notice of the Default to the Defaulting Party and the Defaulting Party shall have thirty (30) days

to commence a cure. If no cure is commenced and timely pursuant then the non-Defaulting Party may give notice of its election to pursue immediate mediation of the issue or to terminate this Agreement thirty (30) days from the issuance of the notice. If the Parties engage in mediation of the issue and are unable to reach a satisfactory settlement, then the non-Defaulting Party shall have the right to terminate this Agreement on fifteen (15) days written notice to the Defaulting Party. Nothing in this Section 11(b) shall limit the non-Defaulting Party's right to seek compensation for any injury or damage to it caused to it by the Default.

9. Rights or Remedies.

Except insofar as is inconsistent with or contrary to any provisions of this Agreement, no right or remedy herein conferred upon or reserved to a Party is intended to be exclusive of any other right or remedy and each and every right and remedy shall be cumulative and in addition to any other right or remedy given hereunder, or now, or hereafter existing at law or in equity or by statute.

10. Assignment.

This Agreement may not be assigned in whole or in part by any party hereto.

11. Notices.

All notices, requests, demands, claims and other communications required or permitted hereunder will be in writing. Any notice, request, demand, claim or other communication hereunder shall be deemed duly given if (and then two business days after) it is sent by registered or certified mail, return receipt requested, postage prepaid, and addressed to the intended recipient as set forth below:

To Customer:

Attn: President

Fax: _____

To Distributor:

Attn: President

Fax: _____

Either party may send any notice, request, demand, claim, or other communication hereunder to the intended recipient at the address set forth above using any other means (including personal delivery, expedited courier, messenger service, telecopy, telex, ordinary mail, or electronic mail), but no such notice, request, demand, claim or other communication shall be deemed to have been duly given unless and until it actually is received by the intended recipient. Any party may change the address to which notices, requests demands, claims and other communications hereunder are to be delivered by given the other party notice in the manner herein set forth.

12. Waiver and Forbearance.

No waiver by one party of any breach by the other party of any of its obligations, agreements or covenants hereunder, shall be deemed to be a waiver of any subsequent breach of the same or any other covenant, agreement or obligation. Nor shall any forbearance by a party in seeking a remedy for any breach of the other party be deemed a waiver by the non-breaching party of its rights or remedies with respect to such breach.

13. Miscellaneous.

a. Governing Law. This Agreement shall be governed by and interpreted in accordance with Alaska law.

b. Forum Selection and Mediation. Any lawsuit brought by either Party to enforce, interpret or apply this Agreement may only be brought in a court of competent jurisdiction in Anchorage, Alaska. The Parties hereby consent to the exclusive jurisdiction and venue of such court. The Parties further agree that, except as otherwise provided herein, prior to the instigation of a lawsuit between them, the Parties shall attempt to resolve their dispute by non-binding medication. Such mediation shall occur in _____, Alaska within fifteen (15) days of the date on which either party requests mediation. The Parties shall jointly select the mediator and shall equally bear the expense of the mediator.

c. Interpretation and Severance. The Parties acknowledge that this Agreement is the result of negotiations between them and both agree that the rule of interpreting contracts against the party drafting the same shall not apply to this Agreement. The unenforceability, invalidity or illegality of any provision of this Agreement shall not render any other provisions unenforceable, invalid or illegal.

d. No Partnership. Nothing herein is intended to create any partnership or joint venture between the Parties. The Parties hereby expressly disclaim any partnership or joint venture relationship between them.

e. Integration and Modification.

(i) This document contains the final entire agreement of the parties hereto. All negotiations, statements, representations, warranties, and assurances, whether oral or written, which are in any way related to the subject matter of this Agreement and the performance of either

party hereto are merged and integrated into the terms of this document.

- (ii) This Agreement may not be modified nor amended except by a writing signed by both parties hereto, and any purported amendment or modification is without effect until reduced to a writing signed by both parties hereto.

f. Force Majeure. Except for any obligation of a Party to make monetary payments, the obligations of a Party hereunder shall be superseded so long as and to the extent that it is prevented or hindered from complying herewith in whole or in part by circumstances beyond its reasonable control, including without limitation, acts of God or public enemy; fire; labor disturbances; strikes; riots; insurrections; civil commotion; storms; earthquakes; lack of suitable facilities or equipment due to damage, shortage of or inability to obtain materials or equipment, or to obtain transportation therefore; laws, rules, and regulations of any governmental agency or authority, including acts of governmental agencies delaying or preventing the issuance of permits necessary to conduct activities envisioned under or required by this Agreement; or any other cause beyond their control, whether similar or dissimilar to those herein specifically enumerated. After the removal of the cause or causes preventing or hindering the performance of the obligation, the party which has been hindered, shall diligently commence or resume the performance of such obligation. Any period or periods of time during which a Party is delayed or hindered in the conduct of operations envisioned under or required by this Agreement due to force majeure shall be added to and so extend any period for action under this Agreement as well as the term of this Agreement.

g. Time of Performance. Time is of the essence in the Parties performance of their obligations hereunder.

DATED as of this _____ day of _____, 20____.

CUSTOMER

By: _____

Its President

DISTRIBUTOR

By: _____

Its President

ACKNOWLEDGEMENT

STATE OF ALASKA)
) ss
_____ JUDICIAL DISTRICT)

THIS IS TO CERTIFY that on this ___ day of _____, 20___, before me, the undersigned Notary Public in and for the State of Alaska, duly commissioned and sworn, personally appeared _____, to me known and known to be the _____ of _____, and known to me to be the person who signed the foregoing instrument on behalf of said corporation, and he acknowledged to me that he signed and sealed the same as the free act and deed of said corporation for the uses and purposes therein expressed pursuant to its Bylaws or a resolution of its Board of Directors.

WITNESS my hand and official seal on the day and year in this certificate first above written.

_____ Notary Public in and for

Alaska

My Commission Expires:

ACKNOWLEDGEMENT

STATE OF ALASKA)
) ss
_____ JUDICIAL DISTRICT)

THIS IS TO CERTIFY that on this ___ day of _____, 20___, before me, the undersigned Notary Public in and for the State of Alaska, duly commissioned and sworn, personally appeared _____, to me known and known to be the _____ of _____, and known to me to be the person who signed the foregoing instrument on behalf of said corporation, and he acknowledged to me that he signed and sealed the same as the free act and deed of said corporation for the uses and purposes therein expressed pursuant to its Bylaws or a resolution of its Board of Directors.

WITNESS my hand and official seal on the day and year in this certificate first above written.

Notary Public in and for
My Commission Expires:

Appendix D- Ice Data

Fort Yukon River Break up Data
AVE DATE 5/10

Breakup Database Search Results

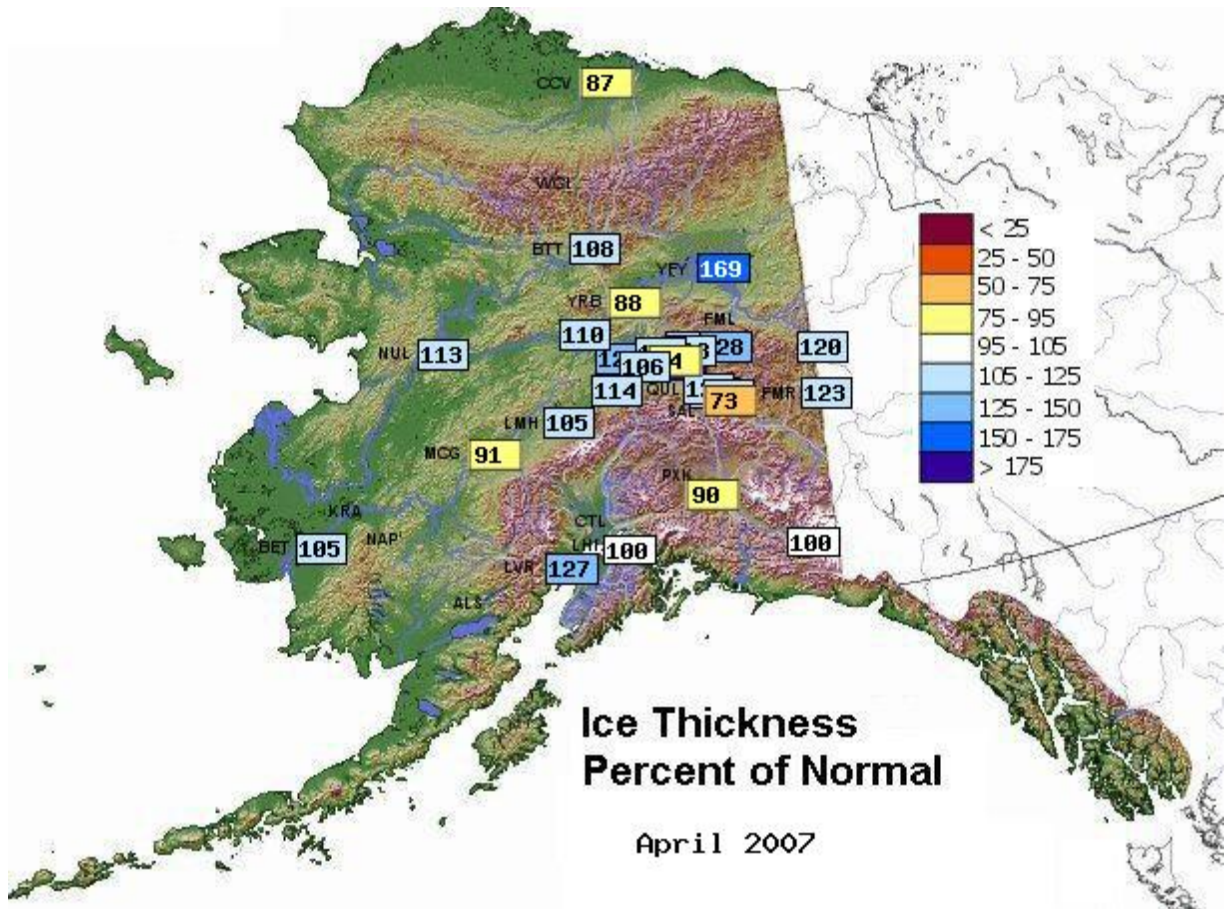
RIVER	LOCATION	BREAKUP DATE	BREAKUP YEAR
Yukon River	Fort Yukon	05-13	0000
Yukon River	Fort Yukon	05-22	1901
Yukon River	Fort Yukon	05-16	1902
Yukon River	Fort Yukon	05-13	1903
Yukon River	Fort Yukon	05-17	1904
Yukon River	Fort Yukon	05-16	1905
Yukon River	Fort Yukon	05-14	1906
Yukon River	Fort Yukon	05-08	1907
Yukon River	Fort Yukon	05-13	1908
Yukon River	Fort Yukon	05-12	1909
Yukon River	Fort Yukon	05-15	1910
Yukon River	Fort Yukon	05-12	1911
Yukon River	Fort Yukon	05-15	1912
Yukon River	Fort Yukon	05-18	1913

Yukon River	Fort Yukon	05-15	1914
Yukon River	Fort Yukon	05-14	1915
Yukon River	Fort Yukon	05-12	1916
Yukon River	Fort Yukon	05-17	1917
Yukon River	Fort Yukon	05-13	1918
Yukon River	Fort Yukon	05-14	1919
Yukon River	Fort Yukon	05-22	1920
Yukon River	Fort Yukon	05-16	1921
Yukon River	Fort Yukon	05-22	1922
Yukon River	Fort Yukon	05-15	1924
Yukon River	Fort Yukon	05-13	1925
Yukon River	Fort Yukon	05-09	1926
Yukon River	Fort Yukon	05-22	1927
Yukon River	Fort Yukon	05-12	1928
Yukon River	Fort Yukon	05-10	1929
Yukon River	Fort Yukon	05-13	1930
Yukon River	Fort Yukon	05-17	1931
Yukon River	Fort Yukon	05-08	1932
Yukon River	Fort Yukon	05-13	1933
Yukon	Fort Yukon	05-10	1936

River			
Yukon River	Fort Yukon	05-15	1937
Yukon River	Fort Yukon	05-17	1938
Yukon River	Fort Yukon	05-07	1940
Yukon River	Fort Yukon	05-12	1942
Yukon River	Fort Yukon	05-10	1943
Yukon River	Fort Yukon	05-14	1944
Yukon River	Fort Yukon	05-19	1945
Yukon River	Fort Yukon	05-11	1946
Yukon River	Fort Yukon	05-14	1947
Yukon River	Fort Yukon	05-15	1948
Yukon River	Fort Yukon	05-18	1949
Yukon River	Fort Yukon	05-12	1950
Yukon River	Fort Yukon	05-12	1951
Yukon River	Fort Yukon	05-20	1952
Yukon River	Fort Yukon	05-14	1953
Yukon River	Fort Yukon	05-13	1954
Yukon River	Fort Yukon	05-09	1956
Yukon River	Fort Yukon	05-18	1959
Yukon River	Fort Yukon	05-05	1960

Yukon River	Fort Yukon		1961
Yukon River	Fort Yukon		1963
Yukon River	Fort Yukon		1966
Yukon River	Fort Yukon		1969
Yukon River	Fort Yukon		1970
Yukon River	Fort Yukon		1971
Yukon River	Fort Yukon		1972
Yukon River	Fort Yukon		1973
Yukon River	Fort Yukon		1974
Yukon River	Fort Yukon	05-03	1979
Yukon River	Fort Yukon	05-05	1983
Yukon River	Fort Yukon	05-19	1984
Yukon River	Fort Yukon	05-18	1985
Yukon River	Fort Yukon	05-17	1986
Yukon River	Fort Yukon	05-14	1987
Yukon River	Fort Yukon	05-05	1988
Yukon River	Fort Yukon	05-04	1989
Yukon River	Fort Yukon	05-02	1990
Yukon River	Fort Yukon	05-05	1991
Yukon	Fort Yukon	05-23	1992

River			
Yukon River	Fort Yukon	05-04	1993
Yukon River	Fort Yukon	05-05	1994
Yukon River	Fort Yukon	05-03	1995
Yukon River	Fort Yukon	05-17	1996
Yukon River	Fort Yukon	05-13	1998
Yukon River	Fort Yukon	05-13	1999
Yukon River	Fort Yukon	05-10	2000
Yukon River	Fort Yukon	05-20	2001
Yukon River	Fort Yukon	05-16	2002
Yukon River	Fort Yukon	05-09	2003
Yukon River	Fort Yukon	05-10	2004
Yukon River	Fort Yukon	05-01	2005
Yukon River	Fort Yukon	05-12	2006
Yukon River	Fort Yukon	05-07	2007
Yukon River	Fort Yukon	05-08	2008
Yukon River	Fort Yukon	05-07	2008



Yukon River Ice Thickness Data
Fort Yukon
2004-2007

YFYA2	FORT YUKON	2004	02-26	28
YFYA2	FORT YUKON	2004	03-02	29
YFYA2	FORT YUKON	2004	04-05	32
YFYA2	FORT YUKON	2005	02-03	54
YFYA2	FORT YUKON	2005	03-03	52
YFYA2	FORT YUKON	2005	04-04	42
YFYA2	FORT YUKON	2005	04-27	52
YFYA2	FORT YUKON	2006	02-06	22
YFYA2	FORT YUKON	2006	03-01	37
YFYA2	FORT YUKON	2006	04-04	28
YFYA2	FORT YUKON	2006	05-01	28
YFYA2	FORT YUKON	2007	01-15	41
YFYA2	FORT YUKON	2007	02-07	51
YFYA2	FORT YUKON	2007	02-09	51
YFYA2	FORT YUKON	2007	02-09	51
YFYA2	FORT YUKON	2007	03-07	54
YFYA2	FORT YUKON	2007	04-05	61

Appendix E - Alternative Harvest

Equipment Configuration

Harvest and Transportation Equipment for Woody Biomass Fuel

An Assessment for Fort Yukon, Alaska



**Bear Mountain
Forest Products**

Bear Mountain Forest Products

5933 NE Win Sivars Drive, Suite 107

Portland, OR 97220

t. 503.334.1558

f. 503.334.1559

December, 2008

Harvest and Transportation Equipment for Woody Biomass Fuel

An Assessment for Fort Yukon, Alaska

Section 1: Overview

This report covers Upstream Supply Logistics for a 3000 dry ton per year Biomass Heating System in Fort Yukon, Alaska. Because biomass transport is limited to ice haul roads, the first priority is to establish the necessary haul requirements within the windows of opportunity for harvesting and movement of material to satisfy the annual proposed heating system bio-fuel needs. Because of climatic issues the schedule to execute most harvest and transport activities is limited to operation from June to September and from January to mid-April. Due to the paucity of roads, the transport system is, for the most part, limited to ice roads on frozen rivers, lakes and muskeg, and in summer, to a barge with a load capacity of approximately 8 tons. Given the limitation on transport to ice roads, outside of road development which may occur as a result of this project, the 3 1/2 winter month “window” translates effectively into approximately 500 working hours. This is based on the following assumption for the year:

June	20 days X 15 hours/ day=	300 hrs
July	22 days X 16 hours/ day=	352 hrs
August	22 days X 16 hours/ day=	352 hrs
September	10 days X 15 hours/ day=	150 hrs

Total Summer Hours		1154 hrs
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January	22 days X 5 hours/ day=	110 hrs
February	20 days X 6 hours/ day=	120 hrs
March	22 days X 8 hours/ day=	176 hrs
April	10 days X 8 hours/ day=	80 hrs

Total Winter Hours		486 hrs
--------------------	--	---------

This scenario requires the movement of 3000 tons of woody biomass from the forest to Fort Yukon over an approximately 500 hour period (486 calculated). The number of loads possible within the 500 hour “window” is a product of round trip (rt) time, a function of speed and distance. It is anticipated the first several project years will concentrate on an adequate supply of biomass within an average 2 1/2 mile radius of the village. Based on a conservative 5 miles per hour transport speed (the ice road speed limit in Canada’s Yukon is 15 mph) and a 1/2 hour load and unload allowance, forest to village stockpile should average 1 1/2 hours. Given 500 conservative winter operating hours to move 3000 tons, loads would have to average 9 tons each (3000 tons/[500 hrs/ 1.5 hrs rt]= 333 loads).

December, 2008

Harvest and Transportation Equipment for Woody Biomass Fuel

An Assessment for Fort Yukon, Alaska



Yukon Flats National Wildlife Refuge in Winter

Transportation of material from the forest to the village is the fundamentally most limiting factor in this project due to the vast majority of movement requiring utilization of ice roads. It has been suggested that a network of land based feeder roads might be constructed to facilitate fire suppression and construct fire breaks, as well as the more efficient movement of forest based fuels. This might prove critical for years requiring material further into the radius of biomass availability and expansion of renewable energy output in the community.

Discussions with the principal sponsors of this proposal have redefined several aspects of the original mission. The majority species targeted for fuel is now White Spruce and other tree types commonly found on higher (drier) ground enabling higher production for a longer season. Another factor which may change is the 8 ton barge load limit because the energy company may own a barge, presumably one other than the existing unit. This is very important, particularly if chipped wood is planned for transport in the summer, and when harvesting and recovery work is initiated on the south side of the Yukon River. The third important change is the possibility of constructing a rudimentary access road system extending the transport time frame and offering greater reliability to the supply of fuel. It may be possible to generate revenue from road construction with most of the same biomass equipment, if the federal and state agencies see sufficient value. The tree removal for roadway construction would also generate biomass for the village heating system.

December, 2008

Harvest and Transportation Equipment for Woody Biomass Fuel

An Assessment for Fort Yukon, Alaska



Mixed Forest - Yukon Flats National Wildlife Refuge

Based on the original equipment list submitted, the activity appears to assume the following scenario: The [Fecon FTX100L](#), equipped with a [15" dual action shear](#) (4 second cycle time at 40gpm) on the front with a rear mounted arch and winch (12000 lb capacity with 75' of 1/2" cable). The Fecon will be able to cut, carry, and aggregate trees up to 15" diameter (see skid steer feller-buncher [video clip](#) for activity). It is also capable of skidding piled loads up to the winch capacity. In the very cold dry snow of Yukon Flats, it is expected to be able to operate in snow depths of around 30". The Fecon will be able to skid the cut, piled trees to an area for load out or further processing.

Also included are a [Kubota M125X](#) 4X4 tractor with loader and a [Kesla Forwarder Trailer with Grapple Loader](#) which would transport materials (delimbed and cut to length) prepared with the [Kubota KX o80](#) Excavator equipped with a [Kesla Processor Head](#). The Excavator would also contribute to the initial felling. The [Vermeer BC 1400TX Chipper](#) is a self propelled manual feed unit with an approximately 15"X20" infeed opening. The chipper would discharge into the Aluminum Chip bin or process logs in the village. Additional attachments include a bucket, brush rake, rear grapple, backhoe and excavator log grapple. The estimated total forest harvesting equipment budget for the aforementioned is \$440,000 plus freight to Fort Yukon, Alaska, or approximately half a million dollars.

December, 2008

Harvest and Transportation Equipment for Woody Biomass Fuel

An Assessment for Fort Yukon, Alaska

Also, within the budget are machines to produce lumber and [firewood](#) for residents of the village. This effort would be eased by employing a delimeter, however, secondary manufacturing represents a minor aspect of the project. Given that the primary intent of the effort is to provide biomass fuel to Fort Yukon, ultimately in the form of wood chips compatible with the K b Pырtec, and that the budget for in-woods operation is to stay within the present confines, it may be worth considering minor changes.

Due to the absence of an efficient means of transporting chips from the forest to the village, chipping of the material in or near the village should be seriously considered. The limbs and tops on the black and white spruce represent between 15 and 31 percent of the total tree volume as defined in [this study](#) as well as [here](#). Delimiting in the forest deprives the heating units of roughly 20% of the available fuel unless the limbs are hand fed and chipped in the forest and transported to Fort Yukon. A more likely scenario is to whole tree transport the material to the village, stockpiling it nearby with year round access to process as needed. This would permit exchanging the Vermeer with its 15"X20" feed capacity with, say a [Woodsman 790](#) with an additional 6' infeed and a 19"X36" opening which can be mechanically fed. At \$73,000, the unit is \$12,000 under the cost of the Vermeer. Avoiding the self-propulsion component of the Vermeer, by using a comparable sized [Woodsman 730](#) (no provision for mechanical feed) at \$30,000 would save \$55,000. This would eliminate the need for the cut to length processing head (Kesla 20SH Harvesting Head- \$48,000). The [Kesla Patu 23G shear/ grapple](#) which could replace it on an excavator or loader application has a 9" cut and costs \$11,500. The 25G with a 10" cut is \$13,500.

The purpose of this exercise is to identify all activities related to this biomass recovery effort and ensure the mechanical and physical adequacy of equipment specified. From forest to chips in the boiler the following components must be executed to accommodate a minimum of 3000 tons per year: Cut, Aggregate, Load, Transport, Unload, and Process, not necessarily in this order. The first two activities in this [video clip](#) (cutting and aggregating) display on a much larger scale what this project will do. In the Fort Yukon case, the Fecon will perform the majority of the tree felling and skidding to a collection area near the river for winter transport. In the initial proposal the Kubota KX080, equipped with a Kesla processor head, would contribute to cutting for removal with a trailer. The Fecon, depending on proximity to adequately sized trees (>8"), would require 400-500 hrs (based on 30 trees per hour at 500 lbs per tree) to cut and pile the minimum annual requirements. The time needed to skid this material to a load-out area will obviously depend on distance. If the above photo is indicative of the area, ice roads are typically close to biomass recovery areas, hence, the Fecon alone could theoretically provide the minimum annual harvesting requirements, staged for winter shipment, within the hours allotted for summer operation.

Transport from the woods to the village was discussed previously concluding the feasibility of 334, 9 bone dry ton loads over the ice roads providing the minimum annual quantity for the proposed village heating system, particularly during the first several years where fuel will be available within a closer haul. Chipping capacity is a function of hp and infeed opening. A good rule of thumb is 10 hp per ton per hour capability. The

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Vermeer is rated at 122 hp , the small Woodsman is 84 hp and the larger Woodsman 790 is 170 hp. The minimum production from the three is 8 tons per hour, more than enough for even the eventual 8000 ton per year requirement. Only the Woodsman 790 has a provision for grapple feeding as well as a live infeed floor, which contribute immensely toward productivity. The final chipped product will require screening (sizing) prior to use in the boilers, and of course, need to be delivered.

The loading and off-loading of logs from the forest to the storage/ chipping area will be facilitated by the loader mounted on the [Kesla Trailer](#), powered by the hydraulics from the tractor.

From a mechanical/ physical aspect, the initial proposed machinery configuration is capable of supplying a minimum of 3000 bone dry tons of chipped biomass to Fort Yukon over a one year period.

Some issues exist such as Kubota M125X Tractor cab configuration (size limits operator ability to turn seat around to facilitate trailer loading), weight in excess of 16,000 lb issue for Kubota KX080 and others. These with suggested alternatives will be addressed in the next section.



Yukon River in Autumn- Yukon Flats National Wildlife Refuge

Section 2: Proposed Changes to Machinery for Fort Yukon Biomass Project

Process systems are best served by some degree of redundancy, particularly when that system is functioning in an area with an extreme absence of support services and equipment like Fort Yukon, Alaska. Machinery will be tasked with operating in a most severely cold environment, where replacement machine parts are commonly days away from obtaining. Because of the need to use ice roads to transport a year's supply of biomass fuel, and the budgetary limitations keeping the machinery to a bare minimum, flexibility is imperative.

Section 1 questioned the need for an excavator and cut-to-length (CTL) processor head insofar as the vast majority of material is destined to become biomass fuel. The CTL process would generate by volume, 15-30% tops and limbs which could not be recovered without in-woods chipping. Because of the weight limits on the barge, containerized hauling would yield around 6 tons per load if the weight of the container/ trailer is less than two tons. Barge shipment requires a shuttle vehicle on both ends (load container and trailer, and unload container and trailer from barge). Chipping in the woods during the summer months will require either access roads from the forest to the village or a larger capacity barge. A 40 yard rectangular 1/4" floor [refuse container](#) weighs around 6300 pounds. 40 yards of Spruce chips at 500 pounds per cubic yard adds 20,000 pounds to total over 26000 pounds. A [trailer](#) and converter dolly will add another 15,000 pounds if the container is to be shipped with the trailer totalling over 41,000 pounds. Efficient movement of chipped fuel necessitates a scale of this minimum.

The barge weight limits affect the selection of equipment as well. Because the machinery must be moved by barge to the biomass gathering area during the summer working period, no one piece of equipment can exceed 16,000 pounds and attachments may require shipping separately.

Equipment Configuration for all required activities.

The initial activity in the biomass gathering process is cutting of trees and retrieving solid fallen trunks. The [Fecon FTX100L](#) (\$115,000) equipped with a [15" tree shear](#) (\$12,000) and an [arch and winch](#) (\$6100, 12,000# capacity) or [rear grapple](#) (\$13,000), will cut and pile as in this [YouTube video clip](#). With either the grapple or winch the same machine will be able to skid the material for consolidation near the location of the winter ice road (the winch and arch may be preferable as the operator cannot see the grapple to align it with the material and the winch will accommodate lots of brushy material drawn up in a choker, and will haul 12,000 pounds).

To assist in the felling and aggregating activities and serve redundancy requirements for transport, substituting tractors with forestry grapples should be considered.

Maintaining the 16,000 lb. weight limit has proven difficult, however, several machines, by removing the attachments for barge shipment, cut it very closely on that limit. Two in

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particular meet minimum specifications (4Wheel Drive with front and rear tires equal size, operator ability to rotate for convenient front or rear operation, hp and hydraulic capability, and ability to accommodate Kesla Shear/ Grapple attachments, and pull trailers of biomass over ice roads with [chains](#) to the Fort Yukon vicinity). Either or both would effectively replace the track excavator's purpose of felling and piling, and be able to skid and transport, and are represented as the [New Holland TV 6070, 145 or 140](#) (base weight 16,187#) and [JCB 4CX](#) (base weight with cab, loader and backhoe is 17,000#). The New Holland is an agricultural tractor which lists new at \$100,000. It articulates and has a PTO on both the front and rear as well as hydraulic hook-ups and valving. The JCB lists for \$116,000 with cab, loader and 14' backhoe (it cannot be purchased without a backhoe, new). Either should accommodate the Kesla 304T (\$21,450) or 305T (\$26,491) ([tractor mount shown on page 20 of brochure](#)), and [23G and 25G grapple shears](#) (\$11,500 and \$13,500, respectively). This configuration would permit the tractor to fell and shear standing timber up to 9" or 10", load and unload cut, fallen, or decked trees on/off a trailer it pulls (10 ton trailer is \$12,000), pull the loaded trailer to Fort Yukon, feed the chipper, and skid material in the absence of the rear loader.

Transport of Material from Forest to Storage and Chipping Area at or near Fort Yukon.

As has been discussed, due to severe weight limits on the barge, transport of material from forest to village must be executed over the ice roads during the January through mid-April window. The biomass would be transported in a whole log form or sheared to accommodate the trailer length. The trailers discussed to date have been the [Kesla log bunk](#) models with either a trailer mounted grapple or as just mentioned, tractor mounted. For another \$12,000 and the cost of a dolly (probably around \$2000), the transport capability would double with the same fuel and labor costs, and extend the distance of feasible biomass recovery. Another option discussed is the use of Roll-Off trailers and containers.

An effective system might involve the use of [2 trailers](#) with [converter dollies](#) and [24' containers](#). Cable Trailers cost \$42,000 and converter dollies \$2500 (used). 40 yard containers are under \$6000. Hook hoist systems from [Stellar Industries](#) cost \$27,156 (model 190-24-40), while their comparable cable systems sell for \$24,740. The price is for a working assembly frame and does not include the cost of a trailer or dolly. While in the short time frame for research a hook hoist trailer did not surface, the additional cost seems to be \$2500.00 if this system is deemed preferable. The ideal configuration would consist of 2 trailers and 4 containers costing approximately \$114,000 (cable hoist). This would provide 2 additional containers to be filled while 2 were being transported. This would allow for winter in-woods chipping, providing a capacity of approximately 10 tons per can. The tractors with chains should be able to pull two trailers. The containers could also be used for logs, or separate log bunks could be constructed, although utilizing containers would bring the advantage of self unloading instead of using a loader. Containers can also be used for back hauling road materials if road building finds its way into the company's activities.

Chipping of Harvested Material

As mentioned previously, due to transport logistics, chipping appears to be more feasibly conducted in or near Fort Yukon, utilizing trees that have been transported in whole tree form. Because the material will be processed outside the forest, utilization of small understory biomass will not be practical, limiting the raw material to trees large enough to economically transport and re-handle. The chipper identified in section 1, the [Woodsman 790](#) has an optional 6' live infeed which offers the ability to mechanically feed the chipper to some extent. It is insufficient to drop grappled material in of any length and leave unattended, but will facilitate a higher modicum of efficiency than a strictly manual infeed. As with any horizontal infeed, smaller material needs to be 'coaxed' by adding longer material periodically, if processing limbs becomes desirable. Keeping a steady supply of trees in the infeed trough should make 15 tons per hour a reasonable expectation. The price of the chipper is \$61,800, with the \$11,000 infeed bringing the total to \$72,800. The spare parts kit costs \$6000. Extra knives cost \$80 each times 6. A [knife sharpener](#), through a nearby company is available for \$1400.

Consideration should be given to the location of the stockpile area for the trees as well as the chipped material. Minimizing the opportunity for contaminating either with dirt should be exercised as it will dull the knives and ruin the boilerfuel.

Prices quoted herein are fob manufacturer or retailer unless otherwise specified. Kesla has quoted fob Anchorage, AK, unless the items would be brought to Iron River, MI, for adjustment or order consolidation. The origin of the equipment is Finland. Consideration of metric to SAE mating should be given if US and European equipment are combined. Kesla's U.S. representative is Rick Lindbeck at 906.361.6666.

Rationale for Stationary Chipping

A summary of the rationale for stationary versus in-woods chipping is offered below:

1. **Machinery Costs-** A containerized shipping methodology, for 2 trailers, 2 dollies and 4 cans will cost around \$113,000. The expanded original Kesla system involving 4 log bunk trailers is quoted at \$54,000. The Kesla units can be used over rough terrain to access the material near where it is cut, hence can assist skidding in moving material for aggregating near the ice roads during the summer months.
2. **Equipment Utilization-** By chipping in Fort Yukon during the period when the machinery can not be in the forest due to ground conditions, the equipment is more fully utilized throughout the year, and will not be competing for usage as it might during the summer harvest or winter transport. Recall that one of the tractor mounted grapples will probably be responsible for moving material to, and feeding the chipper.

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3. **Cellulose Drying Time-** The wood will dry more thoroughly in whole log form than in chipped form and will lessen the need for a large covered storage area. The heating project will probably want a 2 month stockpile of chipped fuel available. As the project moves into electricity production, a 4 month supply would be desirable. Piled logs "keep" better than chips and improve moisture wise over time. Chips stored too long begin to decompose into compost which is detrimental to the fuel quality. It is also susceptible to spontaneous combustion, especially if chipped green and stored longer than several months.
4. **Common Sense-** Our inclination toward a conventional approach disregards the reasons conventional approaches exist. Chipping forest residues at the point of origin is a product of maximizing tonnage for over the road transport with all its restrictions. Ice road hauling does not have restrictions limiting the width or length of loads, or in fact the skidding of loads, if this methodology is found to be most effective for moving the largest volumes. In short, it is possible that we can move as much or more volume in whole log form, than we can by chipping and shipping containerized fuel with a considerably lower capital outlay.

Kesla's U.S. representative suggested we may be able to have special trailers manufactured domestically for less money than the cost of the Finnish Trailers. I believe this is correct, and that trailers with a dump cylinder and a roll-off type frame could be manufactured for this project at or near the Kesla quoted price. I also think the clam bunk concept should be examined as a means to optimize hauling volumes in and out of the woods. In short, if trailers were built to the project's specifications, with the flexibility we have discussed, at a price near that of the Kesla, some in-woods chipping would be possible during the winter months, if it was found to be advantageous.

This report is not an endorsement of any of the suppliers listed. It is an effort to establish a list of machinery capable of fulfilling the minimum 3000 ton per year forest derived biomass fuel objective with some discussion and a "not to exceed" capital budget. It does not include the capital cost of anything beyond the manufacture of single pass unscreened chips.

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Equipment List Summary

Machine or Attachment	Units	Unit Price	Total
Fecon FTX100L	1	\$115,000	\$115,000
<i>Front Feller/Buncher</i>	1	\$12,000	\$12,000
<i>Rear Arch/Winch/Cable</i>	1	\$6,100	\$6,100
<i>Brush Rake/Grapple</i>	1	\$3,800	\$3,800
<i>Dozer Blade*</i>	1	\$4,000	\$4,000
			<u>\$140,900</u>
JCB 4CX	2	\$116,000	\$232,000
<i>Kesla 305T Loader</i>	1	\$26,491	\$26,491
<i>Kesla-Patu 25G Grapple/Shear</i>	1	\$13,500	\$13,500
<i>Front Log/Brush Forks*</i>	2	\$5,000	\$10,000
<i>Swinging Grapple**</i>	1	\$20,000	\$20,000
<i>Snow Plow*</i>	1	\$5,000	\$5,000
			<u>\$306,991</u>
Woodsman 790 Chipper with Opt. Infeed	1	\$72,800	\$72,800
<i>Spare Parts Kit</i>	1	\$6,000	\$6,000
<i>Knife Grinder</i>	1	\$1,400	\$1,400
			<u>\$80,200</u>
Support Equipment			
<i>Welder/Generator*</i>	1	\$8,500	\$8,500
<i>Fire Suppression Trailer*</i>	1	\$12,000	\$12,000
<i>Communications Equipment*</i>	5	\$400	\$2,000
<i>GPS Equipment</i>	4	\$400	\$1,600
<i>PPE*</i>	5	\$100	\$500
<i>Hand Tools*</i>	1	\$5,000	\$5,000
<i>Chainsaws and Supplies*</i>	3	\$350	\$1,050
<i>Maintenance/Fuel Vehicle***</i>	1	\$5,000	\$5,000
			<u>\$35,650</u>

* Estimated Cost- No Firm Quote

** Estimated Cost- Could be \$5000 if Backhoe Jib and Boom can be used

*** Estimated Cost- Vehicle must be able to carry 300 gallons of fuel daily from Ft. Yukon to forest

Equipment Costs of Transportation Options

Option 1: Log Bunk Trailers	Units	Price/Unit	Total
Kesla 10 Ton Trailers	2	\$12,000	\$24,000
Kesla 10 Ton Trailers with Dollies*	2	\$15,000	\$30,000
			<u>\$54,000</u>
Option 2 : Roll-Off Trailers			
Galbreath Cable Roll-Off Trailers	2	\$42,000	\$84,000

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Converter Dolly*	1	\$5,000	\$5,000
40 Yd Roll-Off Containers	4	\$6,000	<u>\$24,000</u>
			\$113,000

Hyperlinks to Equipment Suppliers and Weather Data

[You tube skid steer feller buncher](#)

[ASV PT 100 Forestry Package Brochure](#)

[Yukon Flats NWR website](#)

[Fort Yukon Topo Map](#)

[Fort Yukon Aerial Map](#)

[Porcupine River Lumber Company](#)

[Feller Buncher, Whole Log Skidding, Delimber, Slasher Saw Video](#)

[Fecon FTX100L](#)

[Fecon Dual Knife Shear](#)

[Kesla Attachments, Chippers And Trailers](#)

[Kesla Brochure with the product lines](#)

[Benlee Roll Off Photos](#)

[Compact Track Loader accumulating and piling brush](#)

[Mattracks for tractors](#)

[Benlee Roll Off 24' Trailer](#)

[Woodsman 790 Chipper](#)

[Turbo Saw DFM 3800 Skid Steer Attachment](#)

[Turbo Saw Video](#)

[Stellar Hook Hoist Reference Chart](#)

[Chipper Knife Sharpener](#)

[Komatsu CD60R Crawler Carrier](#)

[Morooka MST 800 VD Custom](#)

[Clam Bunk Attachment](#)

[Small Trees for Biomass Study using Clambunks](#)

[New Holland Bi-directional Tractor](#)

[New Holland TV 140 Specifications <15,000#](#)

[Used New Holland TV 140, Kunau, Preston, IA, \\$47,500](#)

[Historical Average Temperatures for Fort Yukon](#)

[AK State Snow Depth Record](#)

[Photos of Fort Yukon](#)

[Garmin eTrex Legend HCx](#)

[Calculating Ownership and Operating Costs](#)

[Case CX 80 excavator specification sheet](#)

[LinkBelt 75 Excavator](#)

[Vermeer BC 1400TX Chipper Specifications](#)

[Woodsman 730 Chipper Specifications](#)

[Used New Holland TV 145 listings](#)

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[Tire Chains](#)

[Biomass Volumes in Trees by Stem, Branches, Leaves](#)

[Comprehensive Database of Diameter- based Biomass Regressions for North American Tree Species](#)

[Blockbuster 18-20 Firewood Processor](#)

[Blockbuster Elevator](#)

[Kesla Patu 23G & 25G Shear Grapple](#)

[Kubota M125X Tractor](#)

[JCB 4CX](#)

[JCB 2CX](#)

[Terex 980 Elite](#)

[New Holland B115B, pg 19-21](#)

[Texas Pride Roll-Off trailers/ boxes with prices](#)

[Roll-Off container prices](#)

[Converter Dollies](#)

[Fort Yukon January Temperature Record 2008-1993](#)

[Fort Yukon February Temperature Record 2008-1993](#)